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ARMY ORDNANCE

VOL. VI WASHINGTON, D. C., SEPTEMBER-OCTOBER, 1925 No. 32

AIRPLANE VIEW OF ABERDEEN PROVING GROUND, MARYLAND

Photo: U. S. Air Service

SEVENTH ANNUAL MEETING OF THE ARMY ORDNANCE ASSOCIATION, ABERDEEN PROVING GROUND, OCTOBER 2, 1925.

ANTIAIRCRAFT ORDNANCE—YESTERDAY, TODAY, AND TOMORROW
MAJ. G. M. BARNES, Ord. Dept., U. S. A.

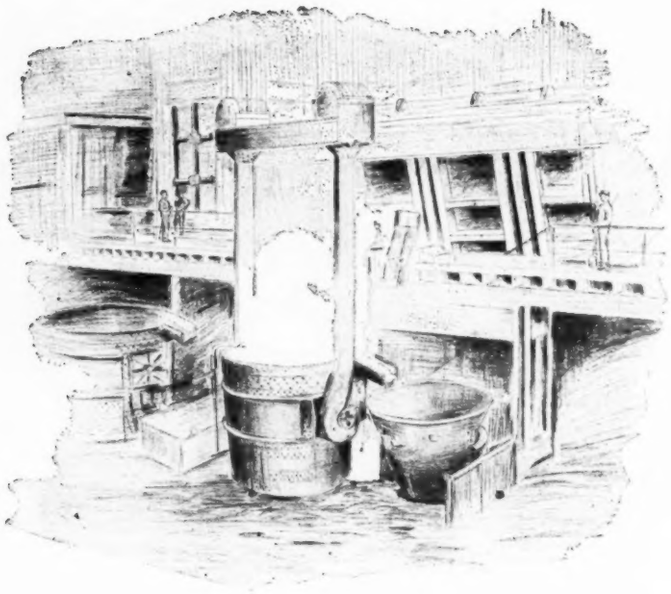
ANTIAIRCRAFT
MAJ. C. G. METTLER, Ord. Dept., U. S. A.

FRANKLIN INSTITUTE
WM. C. L. EGLIN, Sc.D.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION
AUGUST H. TUECHTER

NATIONAL AERONAUTIC ASSOCIATION
GODFREY L. CABOT

AOA
THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION



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THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

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Vol. VI. SEPTEMBER-OCTOBER, 1925. No. 32.

TABLE OF CONTENTS

PAGE

Announcements: The Seventh Annual Meeting of the Army Ordnance Association i

Responsible for Air Program of Army ..... Frontispiece

General Patrick Renamed Chief of Army Air Service 75

Antiaircraft 76
By MAJ. C. G. METTLER, Ord. Dept., U. S. A.

The National Aeronautic Association 81
By GODFREY L. CABOT.

Rear Admiral Wm. A. Moffett, U. S. N 82

Naval Aviation 83
By REAR ADMIRAL WM. A. MOFFETT, U. S. N.

Antiaircraft Ordnance—Yesterday, Today and Tomorrow 85
By MAJ. G. M. BARNES, Ord. Dept., U. S. A.

The Franklin Institute 93
By WM. C. L. EGLIN, Sc.D.

All Phases of Ordnance Studied by Reserve Officers at Aberdeen Training Camp 99

The National Machine Tool Builders' Association 102
By AUGUST H. TUECHTER.

The 9th Corps Area Staff Training Camp, Ordnance Section 105
By LT. COL. FRED L. M. MASURY, Ord. Res.

The Ordnance Trophy 109
By MAJ. GLENN P. WILHELM, Ord. Dept., U. S. A.

PAGE

The Relation Between Pressure, Volume and Temperature of Gaseous Air Under High Compression 111
By COL. EDW. F. MILLER, Ord. Res.

Army Nomenclature 117

Silver Fulminate, an Initiator of Detonation 118
By C. A. TAYLOR and E. P. BUXTON.

The Ordnance Department Reference Library 119

The Behavior Under Stress of the Iron Crystals in Steel, Part I 120
By H. H. LESTER and R. H. ABORN.

Who's Who in This Issue 127

Editorials 128
Seventh Annual Meeting—Today's Targets—Antiaircraft—The Ordnance Trophy—Time Factor in Ordnance Manufacture.

Reserve Corps Notes 130
Ordnance Reserve Training Camps—Recently Assigned Ordnance Reserve Officers—Recently Commissioned Ordnance Reserve Officers.

Professional Notes 134
Salvaging a 12-inch Jacket—Lead Azide as a Detonating Explosive—American Army Rifle Popular in Sweden—Ordnance Organization of Sweden—Leland Stanford University Reconnoiters—Ordnance at Sesquicentennial International Exposition—"Duds" for Coast Artillery—Camp McClellan Ordnance Demonstration—Training Appropriations to Pay for Ammunition—Post-War Development of Propellant Powders—"Tattoo"—16-inch Howitzers at Fort Story Tested—Muscle Shoals Steam Power Plant in Full Operation for First Time.

Book Reviews 139

Recent Patents 146

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THE SEVENTH ANNUAL ORDNANCE

WILL BE

THE ABERDEEN PROVING

October

The National Aeronautic Association, The National Machine Tool

TENTATIVE TRAIN SERVICE

(Trains, as numbered, will stop at Aberdeen on October 2nd. Consult time-table for possible minor changes in time.)

GOING

Southbound—	Pennsylvania	Baltimore & Ohio
Leave Philadelphia:	Train No. 405	Train No. 15
Broad Street	7:20 A. M.	.....
West Philadelphia	7:25 A. M.	.....
Wayne Junction	.....	7:45 A. M.
24th and Chestnut Streets	.....	8:00 A. M.
Arrive Aberdeen	8:56 A. M.	9:26 A. M.
Northbound—	**Train N. 110**	**Train No. 4**
Leave Washington	7:25 A. M.	7:15 A. M.
Leave Baltimore:		
Union Station	8:23 A. M.	.....
Camden Station	.....	8:07 A. M.
Mt. Royal Station	.....	8:12 A. M.
Arrive Aberdeen	8:57 A. M.	8:51 A. M.

RETURNING

Northbound—	Train No. 134	Train No. 20
Leave Aberdeen	8:29 P. M.	9:05 P. M.
Arrive Philadelphia:		
West Philadelphia	9:55 P. M.	.....
Broad Street	10:00 P. M.	.....
24th and Chestnut Streets	.....	10:40 P. M.
Wayne Junction	.....	.....
Arrive New York	12:25 A. M.	.....
Southbound—	**Train No. 129**	**Train No. 9**
Leave Aberdeen	8:40 P. M.	8:20 P. M.
Arrive Baltimore:		
Mt. Royal Station	.....	9:03 P. M.
Camden Station	.....	9:08 P. M.
Union Station	9:25 P. M.	.....
Arrive Washington	10:25 P. M.	10:00 P. M.

SPECIAL TRAINS

A special train of Pullman sleeping cars will leave the Pennsylvania Station, New York City, shortly after midnight, October 2nd, for the Proving Ground. Reservations for this special train should be made to Capt. H. W. Churchill, Secretary, New York Post, Army Ordnance Association, 39 Whitehall Street, New York City.

Tentative arrangements have been made for a special train to bring members from Philadelphia to the meeting. Reservations for this train should be made to Capt. W. E. Ditmars, Executive Assistant, Philadelphia District Ordnance Office, 1325 Widener Building, Philadelphia, Pa.

Reduced fare certificates enabling members of the Army Ordnance Association, the Franklin Institute, the National Aeronautic Association, and the National Machine Tool Builders' Association, to purchase round-trip tickets to Aberdeen at one and one-half times the regular one-way fare have been authorized. Certificates will be mailed all members before September 15th.

MEETING OF THE ARMY ASSOCIATION

HELD AT

GROUND, MARYLAND

2, 1925

Builders' Association and The Franklin Institute Will Participate

TENTATIVE PROGRAM

October 2, 1925

9:30 A. M.	Arrive Aberdeen Proving Ground.
10:00	Mulberry Point—Opening Exercises.
10:20	Demonstration of coast artillery and antiaircraft matériel.
11:30	Aviation Field—Military and commercial aircraft, aircraft armament and bombs.
12:00 M.	Dinner.
1:30 P. M.	Museum—Demonstration of ordnance mobile repair shop equipment.
2:00	Main Front—Mobile artillery demonstration.
3:00	Main Front—Automotive demonstration.
5:00	Business meeting of the Army Ordnance Association—All guests are invited to attend.
6:00	Supper.
7:00	Main Front—Antiaircraft and pyrotechnic demonstration.

(Detailed program of all events will be distributed at the Meeting.)

RESERVATION OF MEALS

The Commanding Officer, Aberdeen Proving Ground, Maryland:

I desire to attend the Seventh Annual Meeting of the Army Ordnance Association to be held at the Proving Ground, Friday, October 2, 1925, and I request that you reserve ..... dinner ($1.50 each) and ..... supper ($1.50 each) for me on that day. I am enclosing my check for ..... drawn to your order.

Please send Meal Ticket to: .....

(Member A. O. A.)

.....

(Address)

NOTE.—This reservation must be mailed to reach the Proving Ground not later than Friday, September 25, 1925. Since all food is shipped from Baltimore by a caterer, it will be impracticable to refund for meals once ordered.

Responsible for Army Air Program

MAJ. GEN. MASON M. PATRICK, U. S. A.
Chief, Army Air Service

BRIG. GEN. JAMES E. FECHET, U. S. A.
Assistant Chief, Army Air Service

General Patrick Renamed Chief of Army Air Service

General Fechét Assistant Chief

MEMBERS of the Army Ordnance Association and all others interested in adequate munitions preparedness will be pleased to learn that Maj. Gen. Mason M. Patrick has been renamed, by the Secretary of War, Chief of the Army Air Service upon the expiration of his present term in that capacity.

Likened to manufacturer and consumer, Ordnance and Air Service have much in common. The design and manufacture of bombs which promise to become such potential factors in future war is a responsibility of the Ordnance Department; the use of this weapon is the function of the Air Service. The latter is, therefore, the best customer of the Ordnance Department for this commodity. It is by nature, therefore, that the Air Service and the Ordnance Department should work in close coöperation in their effort to afford the best possible protection for the country through the use of the airplane and bomb. No better example of the harmonious relationship between the two services now existing can be cited than that of the important work now going on at the Aberdeen Proving Ground where Ordnance and Air Service officers are conducting important developments along these lines with the utmost coöperation and excellent results.

The opinion seems to be rather unanimous that Maj. Gen. Mason M. Patrick, Chief of Air Service, having been recommended by the Secretary of War, will be reappointed to the position which he has so ably filled during the past four years, indicating that his constructive development of our Air Force has met with the general approval of his superiors.

General Patrick came to the Air Service from the Corps of Engineers, a branch of the service in which he served continuously since his graduation from West Point in 1886. During the World War he was appointed by General Pershing as Chief of Air Service, American Expeditionary Forces, and his exceptional record in that capacity led to his appointment, on October 5, 1921, as Chief of the Army Air Service, with the rank of Major General.

A builder and organizer, General Patrick has laid a firm foundation on which our air defenses of the future will be based. He has fostered aeronautical research and development until America has been able to take and hold a majority of the world's records for aircraft performance. With the money appropriated by Congress for aircraft, he has caused the large war stock of airplanes on hand to be repaired and improved for use until new and better designs were produced. Now that the war-built planes are about exhausted, he is placing orders for new replacement designs embodying the best types of airplanes to be procured under present day development.

General Patrick not only has the respect and admiration of the entire personnel under his charge, but the confidence of the country at large. Through his devotion to the task of creating a bigger and better air force he has gained many adherents for this newest branch of this country's military forces. His encouragement of commercial aviation has played no small part in a revival of interest in the possibilities of the airplane as a fast and effective means of transportation and, judging from recent activities, the prospects for the commercial development of aviation in the near future are bright.

General Patrick bears the distinction of being the oldest officer in point of age and service to fly an airplane. At the age of 59 he began instruction at Bolling Field, and the day he qualified as a pilot and received his "wings" he cemented a bond between himself and the younger officers under his command. He uses the airplane as his means of transportation in many of his inspection trips to various Air Service activities, and hence "follow your leader" is no better exemplified than it is in the Army Air Service.

General Fechet, Assistant Chief of Air Service

Brig. Gen. James E. Fechet, or General "Jim," as his friends call him, has occupied the post of Assistant Chief of Air Service since last April when he succeeded Brig. Gen. Wm. Mitchell. When he came to Washington from Kelly Field to take up his new duties he was reported to have said, "I'm here to carry out General Patrick's orders. I believe General Patrick can make this the best Air Service possible, and I hope to help him do it." Knowing this officer's devotion to the Air Service there can be no doubt that he is doing his utmost to further the interests of this branch of the service in every possible way.

General Fechet rose from the ranks, being commissioned in the Cavalry in 1900. Wounded in action in the Spanish-American War, he also served in the Philippine Insurrection, and with the Punitive Expedition under General Pershing in Mexico. He is a graduate of the General Service School, Fort Leavenworth, Kansas.

General Fechet joined the Air Service at the outbreak of the World War, and lost no time in learning to fly. Throughout his service with that Branch, he has filled positions of responsibility, being at various times in command of Scott Field, Carlstrom and Dorr Fields and Kelly Field, the latter being the largest Air Service activity in the country. For four years he served in Washington in the Office, Chief of Air Service, as Chief of the Training and War Plans Division, in which capacity he formulated the various policies of the Air Service with respect to the training of Air Service personnel and their preparation for war.

General Fechet's career has been of such a character that he was the popular choice as the successor of General Mitchell as Assistant Chief of Air Service.

Antiaircraft

By

MAJ. C. G. METTLER, ORD. DEPT., U. S. A.

SITTING here in the Ordnance Department, where we pass on guns and ammunition for both the aircraft and the antiaircraft forces, it is impossible to enter the literary arguments of the press concerning their effective power on one side without disregarding a pile of papers in the "In" basket which support the other. As we see our job, we must pass the most effective designs for procurement to each service and let them shoot it out for better, for worse. However, we have our own opinions on both sides and expect to express hereafter our desk opinion of the antiaircraft problem.

Let us look for a moment at this task from the standpoint of the hunter. What kind of a bird shall we load for? What dogs shall we take? So far as we have noted and so far as antiaircraft is concerned, this bird, the airman, is not flushed from a clump of bushes as we steal upon his cover, guided by sharp nosed setters. He does not circle down to swim among a flock of decoys before our well camouflaged shooting box. He is rather an eagle or a hawk coming from a far off protected nest, sailing high in the atmosphere, with a definite mission to destroy his enemies and sustain his friends. Can we here on the ground, protecting from his hungry talons the chickens we have raised with so much care through the damp spring days, divert him from his purpose? Can we make those pretty wings fail to suspend him in his chosen element and see him tumble end over end into the clover field, a sinister trophy to be hung aloft as a warning to his brethren? Again he is an owl flying high in the darkness, knowing from the reflected starlight in the streams and lakes to find his way, and he swoops at the proper moment swiftly, surely down upon our guarded treasure, strikes and is away. Can we see him to aim our weapon, fire it to frighten or to destroy, or even blind him with our candle power? 'Tis true, he is still a noisy bird, telling the high heavens and all beneath that he is in the air, but he will learn to be more silent. And he is fast. Sometimes, three miles per minute, over 260 feet per second, is his terrific speed. Sound travels only 1,000 feet per second. If he be a mile away, five seconds must pass until we hear his humming drone at any point. And when we hear it, he is not there, but a quarter mile ahead.

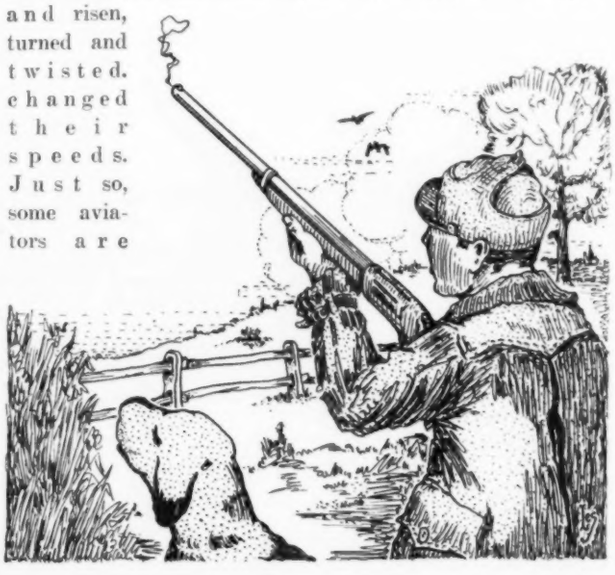
Even with our best guns and gunnery, he may make us stand armed at the hennery day and night by his very presence in the sky. He may hide behind clouds to await his chance, may even fly low across the fields behind the woodlands and hills, yet when his chance comes, when our eyes are weary, he may mount high and come upon an unobstructed, straight line path direct to his destination.

But even with his swiftness and cunning, if we merely stand on guard, however gun shy and fearful, we are to him a potential menace. If he come at all before our scarecrow presence, he comes nervously, casting one eye in our direction and with his other getting one-eyed results from his journey. If we fight with vigor and confidence and scatter shell fragments and shrapnel balls about his rigging, his mind and hands forget their mission in the fear of annihilation and turn him upward and away.

Suppose we have only a little flock to care for, it may be concealed from his observation, but chickens, like soldiers, are very hard to keep under cover. And besides, the chicken stealer has other sources of information than his sight alone. He comes more often with an exact knowledge of the location of our hennery, notes its condition and protection each time he passes overhead and in his own time gets what he may from its contents.

On the other hand, confident of our marksmanship, we may expose our flock to tempt the flyer within our gun range, hiding ourselves and arms along his line of descent. With good fortune and enough trickery, we might some day nail his propellers on the hennery.

When one thinks of it broadly, there is a lot of individuality to such game hunting, just as we find individuality in the duck or partridge. I have seen many game birds fly directly behind a tree all the dangerous part of their escaping flight. I am sure they must have figured out this cunning safety code. Some have flown along a curved path until beyond my range, have dropped and risen, turned and twisted, changed their speeds. Just so, some aviators are



born dodgers in the air, think quickly, dive for shrapnel bursts, turn and flatten off at the right time to avoid defeat and disaster. Others, less brilliant, come sailing directly, unhesitatingly into the field of fire and through it, often emerging, by reason of good fortune, not good judgment, without a scratch upon their fuselage. Really it's a great game, if our heart's tenderness will permit us in these quiet hours of peace to think of it in such a light. When bombs fall on our churches, our factories and homes, killing our friends and kin, we will have worse thoughts than these. It will be too late then to learn hawk hunting.

Rock Island Arsenal

Note the bridges, power dam, shops and storehouses of an important Government plant which may require antiaircraft defense in time of war. The target is beautifully outlined by water, easy to identify, and readily put out of action by bombing.

Let us drop the hunter for the moment and ride with the military aviators over the fields and cities of our enemy, over his marching armies and the trench lines of the battlefields on a trip of exploration to discover what he may find to attack. Perhaps here we may learn how we may defend our country and army against the hostile airman.

Below are machine shops turning out shell and shrapnel for the hostile guns. Beyond are magazines, indicated by spreading railroad tracks, storing his explosives and ammunition. There are his wharves, receiving from laden ships his overseas support. They are all fine targets for a bomb or two.

Turning to the open country, we see his supply trains running from the bases and depots to the railheads across viaducts and light bridges whose destruction would delay him many days along the battle line. Beyond the railheads are crawling solid lines of trucks onward to the distributing centers near the battle lines. Turning over a few trucks with a bomb on the highway would give him hours of trouble.

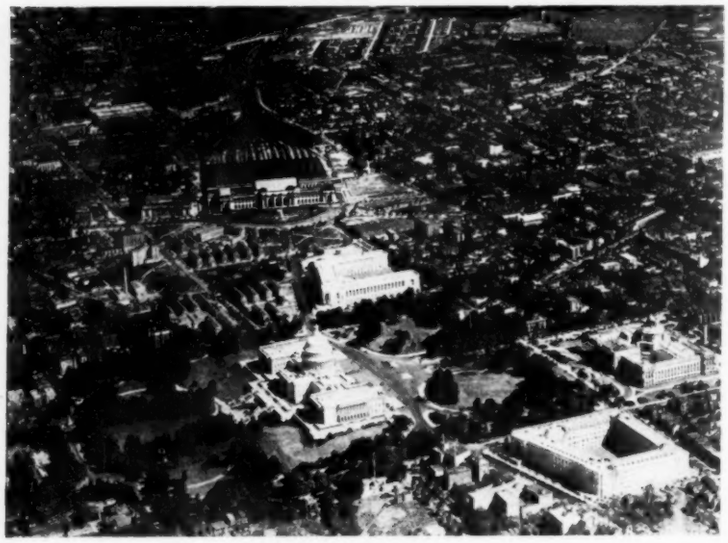
A familiar sight behind the firing line—easily and disastrously damageable by aircraft bombers.

Back of the lines are bivouaced the tired troops recovering their strength and spirits for new efforts on the line. Our machine guns might strain their shattered nerves beyond the breaking point. On beyond there are marching columns of artillery and cavalry, whose horses might be frightened or destroyed with well placed fire or some fragmentation bombs. On the lines are groups of men, hidden behind obstacles awaiting the signal to advance. Breaking their formation would delay their attack. Here are lines of men going forward to the attack, supported by the fire of their field batteries. How would their courage stand a swooping attack with our machine guns along their backs? How would their batteries sustain them with barrage if we attack their positions with bombs and gun fire? We find infantry, cavalry and artillery on the march easy targets for machine gun fire unless they are prepared to resist our attack.

Let us go home from this reconnaissance to think over the protection of our own ground troops from the attacks we might have made.

First and foremost, we must consider our own air forces. They must prevent the enemy from coming over, or finding him already over must drive him back or bring him down. That is the desirable thing. But the air is so big. The radius of planes and ships is so large. No nation could build ships and train men to fill the air. Ships

grouped for fighting must leave some places unprotected. Should we not concentrate our aircraft for attack instead of dividing it for defense over wide areas? If so, we must defend locally the individual units, the lines of communication, the dumps, railheads, storehouses, magazines, factories, wharves and cities. This is the function of antiaircraft armament and troops. It has been done and it must be done again!



Washington, D. C.
Antiaircraft defense should be arranged for the adequate protection of the central offices of our Government.

Perhaps the greatest and most effective defense ever carried out against aircraft was the defense of Paris during the World War, especially during the latter part of it in the summer of 1918. Some twenty to fifty miles away from Paris were located watchers who warned the central station of the approach of the enemy, and on beyond these were the firing lines who gave information of aircraft going over toward Paris. Around the outskirts of Paris, was located a net work of guns which could cover almost all the sky area. On account of their considerable range, they were not so very close together after all. I am informed that there were 208 antiaircraft guns, handling the antiaircraft gun defense, and some 113 machine guns. Somewhere around this net work and in advance of it, were located listening posts with large listening horns which would indicate the path and altitude of the approaching enemy, and also around this area were located some seventy searchlights which were directed by the listeners upon the part of the sky where the enemy was approaching. On the landing fields near Paris, were located fifty-eight airplanes which could be sent into the air in ample time to meet the oncoming enemy and attempt to drive him away. In each center, arrangements were made to divide the fire of the antiaircraft battery so that each enemy plane was subjected to some sort of harassing attack. Around the city and beyond its limits, were constructed various devices to fool the approaching enemy as to his objective. Lights were placed on spots which he might bomb without effect. Machines were set up to produce smoke clouds and alter the appearance of the city to prevent him from locating important areas. Balloons were sent up between Paris and the enemy, with dangling cables, into which he might fly and with machine guns to fire at him and telescopes to observe him. A central command was established which controlled all the defense within one well protected room. From here the attack was directed and the population warned in the areas which were threatened.

Let us see what the effects of this preparation amounted to. The French reports indicate that some twelve Zeppelins in all attempted to make air raids on Paris on three different occasions. Of these, six were destroyed and only four succeeded in passing over the city. The Zeppelins were made a failure by the antiaircraft defense and practically no attempts were made after October, 1917.

In all, some 500 planes attempted at different times to fly over the city of Paris, and according to Paris reports, less than fifty succeeded in accomplishing their mission, that is, less than ten per cent.

Most of the attacks were made at night, especially in the latter part of the war, and at this time no airplanes were used to combat them. Some fifteen planes were brought down by the antiaircraft defense, and the German prisoners testified that many planes were hit, turned back and regained their lines before coming down.

At one time, the Germans sent over by airplane 22,000 kilograms of loaded bombs to be dropped on Paris. Only 1,060 kilograms of them were dropped on the city and the destruction caused by these was repaired in a few days.

Wilson Dam, Muscle Shoals, Ala.
Here stands a monument of construction which adds over 200,000 h. p. to the strength of the United States. It requires protection against aircraft bombing.

Over 20,000 kilograms were turned back and wasted. An aviator does not land with bombs on his plane. They are too sensitive to bumps. If he cannot drop them on his objective, he drops them somewhere else, no matter what

effect they may produce at the place of dropping.

Several books have been written on antiaircraft defense. An excellent one has recently described the defense of London. One may readily compare this defense with that of Paris. The results were mediocre. Poor types of guns were assigned to this duty. Many of the troops conducting this work were rejected for field service. Yet the very presence of the armament and men in action served to turn back many raiding planes, to break up formations and divert well organized attacks from their objectives.

The strongest German antiaircraft defense was located around Leverkusen and Schlebusch, where the explosive and ammunition plants were located. No bombs were ever dropped in the vicinity of these plants, although attempts were made to bomb the bridges at Cologne nearby. The antiaircraft defense prevented any considerable damage. Here, one plane from the Allied Forces wound up a suspended cable in its propellers and fell at Diedenhofen in January, 1918. The Germans reported that they dropped seventeen Allied planes along the Somme and the Aisne with antiaircraft guns in one day, August 8, 1916.

In its protection of the troops at the front from observation, from attack by machine guns and from bombing of their treasures of ammunition and supplies, antiaircraft defense often did remarkable work. In the early part of the war, the British found that they had brought down one plane for 8,000 shots. At a later period they brought down one plane for 4,550 shots, but in some areas toward the latter part of the war they

Paris
The Etoile, center of Paris from which aviators locate its important facilities. ' After all, little importance can be attached to the bombing done by the Germans due to the vigilance and effectiveness of the antiaircraft defenses of Paris.

accounted for a plane with every 1,500 shots. Firing at the rate of 15 shots per minute with ten guns, this was ten minutes of fire per plane.

In our own service, 5 antiaircraft batteries which saw service at the front in France in 1918, fired 10,275 rounds at airplanes, and in these firings brought to the ground seventeen planes, an average per plane of 605 shots. Considering all the antiaircraft batteries in the United States

New York City
A pearl of great price—the business mecca of the world and an ideal target for the bomber.

Army area, the average per plane was about 1,000 shots or six minutes of fire with ten guns. Two of our antiaircraft machine gun battalions in 1918 from September until the Armistice brought down 41 planes with an average of 5,500 shots per plane. At the present time, our gunners are hitting at the rate of one hit per 100 shots, but all hits do not drop a plane as indicated by recent tests at Aberdeen.

Aviators have inherited the knowledge of the antiaircraft defense on the ground, and coupled with the antiaircraft defense in the air, there is quite a bit to worry about when the order arrives to go over and attack some well defended place.

Since the World War, a great many improvements have been made in aircraft. Greater speeds have been accomplished; greater bomb carrying capacity has been attained and even greater protection to the plane itself. The aviators themselves have learned much from the fighting in the World War, have gotten up schemes to maneuver and better aiming devices. They are handling themselves better in the air than they did before, and even know more about the problems of antiaircraft gunnery. They have learned more about the problem of attacking enemy planes; have learned to fly at night; have better methods of landing in the darkness; are perhaps better trained in finding their way about and know more about the identification of objects which they are sent to locate. They have been furnished better cameras, better schemes for printing and reading photographs and can make a map of an area from an almost invisible height.

In the meantime, the antiaircraft forces have not been asleep, although their advance has not been so marked nor

so widely heralded. They have, however, been able to fire at longer ranges, to fire higher, to burst their fuzes more accurately, to supply their projectiles with better tracers to indicate their trajectories in the air, to fire their guns more rapidly, to lead their target more quickly, to conceal themselves more securely, and finally, to produce more effect with their bursting shell.

3-inch antiaircraft guns in action against aerial targets. They are not yet scoring quite so consistently as an expert wing shot but they are getting better and better. This sort of shooting requires the best firearm that can be made and no guessing.

They have developed better listening devices to indicate the approach and path of the hostile airplane, to determine the altitude at which he is flying, to make more accurate corrections for wind, atmosphere and powder. They have learned visually to measure the rate of the airplane, both horizontally and vertically, and to plot where he will be when the projectile reaches that vicinity. They have learned more about airplanes and their flight, can identify types and predict their behavior; they know where an aviator must be in order to drop his bomb effectively on a known target, the direction he must take and the altitude at which he can fly with the load which he is carrying. They are using the radio, the long range camera, the moving picture machine, and every modern improvement to enhance the value of their fire.

The Army has not yet covered the whole field of work for antiaircraft. No definite decision has established just how our Infantry, Cavalry, Artillery, Engineer and Supply columns will protect themselves on the march from aircraft attack. No field organizations have attempted—except in a few instances—to get a solution for their problem. The protection of important areas has not been solved beyond tentative plans based upon the defenses of Paris and London. We are still driving away at the fundamentals of the problem, whether the airplane can be hit and the aviator diverted from his mission by any armament and control instruments so far produced. We know part of the solution. We have data to make better guns, better mounts, better ammunition, better fire control. Elsewhere in this magazine is described the progress made in armament and instruments, compared to the progress in aviation. A thorough plan for co-ordinating the various weapons, the locating, and position finding instruments and the transmission systems into one harmonious defense is demanded. Then what we need to know is the organization for using the armament and its accessories, the assignment of fighting units to a definite defense, the actual solution of that defense to indicate its deficiencies and then to have a recheck of our developments to determine what else will be needed; in what quantities all the variety of equipment will be required; and the completion of plans for its procurement, issue and maintenance. In order to work out these features, we need above all else the wholehearted enthusiastic mutual support of our antiaircraft forces and our Air Service. It is the problem of the Air Service to relieve itself from defensive work by the best development of antiaircraft and to find its greatest work in the mass attack of our enemies in the air and on the ground.

We are convinced of the necessity for antiaircraft and know many of its limitations. We know that it takes many rounds from any gun to score a hit upon an airplane. We know also that tons and tons of bombs from airplanes cannot win wars or entirely destroy our cities and homes. No one has ever determined the quantity of high explosive that was fired into Verdun, but it did not fall. It is still there and still French. It takes thousands of rounds of ammunition to kill one man on the battlefield.

But with all the data we have, both aircraft and antiaircraft are still in infancy. Standardization has not set in. Their progress will not have reached the stage of quantity production for several years. Neither can clearly state its full war possibilities or war probabilities and each will counter the other in war as armor and armament have done in the past.

Aircraft has the advantage of peace-time usefulness and has grown a little faster through commercial progress. Antiaircraft has no other peace-time usefulness than as a training tool for war. It has the disadvantage of depending upon its rival even for this usefulness; that is, in the handling of its real target at which it may fire. Antiaircraft needs a maximum army effort to prepare itself adequately for its war-time task. It needs a large share of army money to develop suitable tools in adequate quantity.

Antiaircraft will never be one hundred per cent effective, nor will it ever be omnipresent to resist aircraft attack. But in its field, it has great value and must not be neglected. It is a function of our armies to learn what kind of armament can best perform the duties required, what instruments can best direct and discharge this armament and what training must be done to use the armament and its directing instruments.

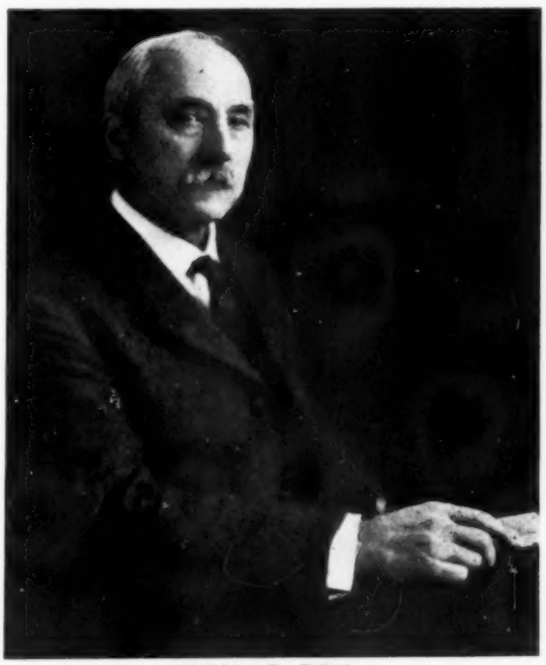
Human ingenuity is just as alert in defense as in offense. We can expect that no great invention for destroying life or property will come forth which will not quickly stimulate the people to provide a worthy device to counteract its effect.

The National Aeronautic Association

By

GODFREY L. CABOT

ORGANIZED for the general purpose of carrying on the activities formerly performed by the Aero Club of America, the National Aeronautic Association was established to become the representative in the United States of the Fédération Aéronautique Internationale which has charge of aeronautic sporting events throughout the world. The National Aeronautic Association, during its comparatively brief existence, has established a very creditable record of service in authenticating flying records, establishing standards of excellence for pilots, promulgating information and rules for the guidance of flyers, and standardizing instruments of precision.



Godfrey L. Cabot,
President, National Aeronautic Association

Howard E. Coffin, formerly head of the Government Air Service, was the moving spirit in establishing the N. A. A. and was its first President. Re-elected for a second term, he soon resigned to make way for Mr. Frederick B. Patterson, President of the National Cash Register Company of Dayton, Ohio, who, with true public spirit, consented to assume this responsible position, wherein he acquitted himself with great success. The author of this paper was elected President last October.

The roster of distinguished men who have taken a personal interest in the matters of the Association includes, first and foremost, Mr. Orville Wright, Chairman of the N. A. A. Contest Committee, the first flyer to make a successful flight in a heavier-than-air machine. Follows a galaxy of names that will stand high in the history of American aeronautics: Admiral Wm. F. Fullam, U. S. N., Retired, whose enviable record began in his duties as midshipman at Annapolis and continues today as one of the leading aeronautic authorities in the world; Mr. Harold H. Emmons of Detroit, Mich., whose civic activities and interesting South African travels have made his name known in a very wide circle; Mr. Carl B. Fritsche, Governor of the National Aeronautic Association for Michigan; Mr. Elmer A. Sperry of New York, known the world over for his gyroscopic compasses used on nearly every seagoing vessel; Mr. E. P. Warner, prominent aircraft engineer; and Mr. Wm. P. McCracken, Jr., of Chicago, Chairman of the Aeronautical Committee of the American Bar Association, and presiding officer at all annual conventions of the National Aeronautic Association.

Mr. Coffin, while President of the N. A. A., went abroad and established relations with the Fédération Aéronautique Internationale and was very successful in securing the adoption of certain American ideas in international councils. His interest and general assistance have been beyond value to the Association since its foundation.

During the presidency of Mr. Patterson, the membership of the Association was greatly increased by a very vigorous and well conducted campaign.

During my tenure of office it has been my good fortune to spend the greater part of this year as a resident of Washington, and I am happy to say that very close and cordial relations have been established with nearly all the Departments of the Government.

Details are now being arranged for the Annual Convention of the Association to be held in New York, October 8, 9 and 10, 1925.

The National Aeronautic Association has received the enthusiastic commendation of both the Army and Navy as evidenced by letters from the Secretaries of War and Navy and from the Postmaster General.

During the brief life of the National Aeronautic Association the United States has advanced in flying until it now holds more air records than all the rest of the world combined. It is our aim to make America not only first in the air but to attain the same preponderance in air traffic over other nations that she now has in the automobile industry, and it is our firm belief that this end will be accomplished before many years will have passed.

REAR ADMIRAL WILLIAM A. MOFFETT, U. S. N.
Chief, Bureau of Aeronautics, Navy Department

Naval Aviation

By

REAR ADMIRAL WILLIAM A. MOFFETT, U. S. N.

NAVAL AVIATION is that arm of the Naval Service which has been developed in the United States Navy to meet the problems of aircraft operations at sea with the Fleet. It is a part of the Navy just as the destroyer service, the submarine flotillas, the cruiser divisions and the battleship force are parts. In addition to actually operating aircraft at sea with the Fleet, Naval Aviation has to do with the development, experimental and research work necessary to bring to ultimate perfection the new and undeveloped possibilities of this operation of aircraft as a part of the Fleet.

When we consider that the first plane to fly in battle made its appearance in this capacity scarcely more than ten years ago and that the first war pilots who met over the German and Allied lines waved greetings to one another in passing, we can understand just how much of an innovation is the use of aircraft in war. One day during this early period in the World War, one of these pilots fired his pistol at an enemy plane. From this episode the airplane as an offensive instrument in war, equipped with especially designed ordnance, has developed to surprising proportions.

Naval aviation in some respects antedated this historic incident. In 1911 the American Navy began seriously to investigate the possibilities of using aircraft in Naval operations. A group of Naval officers was trained under the supervision of the Wright brothers and Glenn Curtiss in the rudiments of aerodynamics and air navigation. They were already thoroughly grounded in the principles of naval strategy and seamanship. They knew the difficulties that must be overcome in so far as asserting mastery over the sea was concerned. It remained for them to study the capabilities of aircraft and adjust these capabilities to the limitations imposed by operations at sea. After the rudiments of flight were mastered, steps were taken to apply the lessons to the problem of operating planes from ships. And the first landing to be made by a plane on the deck of a ship was accomplished on a vessel of the United States Navy more than thirteen years ago. This feat in reality marked the beginning of naval aviation.

Naval aviation was called upon to prove itself when the United States entered the World War. A Naval Aviation Unit was the first armed force to land in Europe after the declaration of war. Under the press of the emergency this small detachment grew to enormous proportions and at the close of the war had an enviable record of achievement behind it.

It is little known that more than 800,000 square miles of submarine-infested waters were patrolled by American Naval seaplanes on the Western shores of Europe; that twenty-seven Naval Air Stations were established in England, France and Italy by the American Navy to carry on this work and that not a single convoy escorted by Naval planes was successfully attacked by German submarines.

But this was a specialized work for Naval Aviation. It was carried out with but one purpose in view—the curbing of the submarine menace—to the end that cargo vessels and troop ships might safely reach port. The larger problems of development—the application of aviation to the needs of the surface fleet had perforce to await the end of the war. Naval Aviation as a factor in the operations of a high seas fleet is a post-war development, and one that has only begun to demonstrate its possibilities. The last six years have been filled with this new development and much has been accomplished.

Following a policy with respect to aviation laid down by the Navy Department, several lines of development have been followed. The airplane carrier has been put through a program of experimentation and investigation which we feel sure will give us the best development along this line in the world. Aircraft service to the ships of the Fleet as observation and spotting planes has been perfected to a great extent, and the ship's plane now forms an integral part of the fire control system. Airplane spotting gives an advantage in the control of gunfire to a ship which is comparable to a mast several thousand feet high. From the vantage point of the plane, the panorama of the battle is spread out like the details of a carpet to a man who is standing on it. What the pilot in the plane sees he sends by radio as information to the ship. He directs the gunfire from his lofty station so that it may hit the target even though the target vessel may be out of sight from the deck of the firing ship.

In order to render the plane capable of operating from the ship's deck we have perfected the catapult, and are the only nation which has developed this mechanism. The catapult literally shoots a plane into the air at a speed of sixty miles an hour. It has made possible the carrying of planes on all of our battleships and cruisers.

One of the major problems was the development of proved types of aircraft suitable for use on shipboard to perform all the functions of war planes. These include the fighting plane, observation planes and patrol planes. We now have approved types of planes for each of these functions.

As an example of the particular problem offered by Naval Aviation as distinct from the general problems of aviation, we may cite the development of the combined scouting, bombing and torpedo plane. In a single type has been combined the functions of three separate planes. In other words, this plane may be used to carry bombs, or it may be used to carry and launch a torpedo, and if the problem calls for long distance scouting, fuel is substituted for the ordnance load, and the plane can scout over a distance of from 1,600 to 2,000 miles without refueling.

Let us look at some of the outstanding accomplish-

ments of the Navy in aviation since the war as an illustration of the rapid development of this fascinating art.

The U. S. Navy built the first wind tunnel in the United States.

In the construction of the SHENANDOAH a new and important metal was given to the trade in this country, duralumin, an aluminum alloy.

The development of all post-war aircraft engines both air-cooled and water-cooled has been to a large extent by the Navy in conjunction with the aircraft industry.

Naval plane types have been reduced to five and to a great degree standardized.

The design of the SHENANDOAH was the first large rigid airship design ever undertaken in this country.

The design and installation of catapults on board U. S. ships is far in advance of that of any other country.

The Navy holds the land plane speed record of the U. S. and the seaplane speed record of the world.

The Navy developed the use of the LANGLEY arresting gear which, we believe, is at least equal to that of any nation.

At the close of the war there was practically no aviation except as represented by large flying boats for patrol duty. Experiments have led us to satisfactory types for operations from all classes of naval vessels.

From the point of view of organization and operation the following are essential accomplishments:

At the behest of the Navy Department, a Bureau of Aeronautics in the Navy Department was established by an act of Congress in 1921.

The Navy has created a real Naval Aviation organization that is a fleet air arm for operations with the Fleet in squadrons from aircraft carriers, and from ships of all classes—battleships, cruisers, destroyers, submarines and train vessels. Its functions in coast defense have been designated by the Joint Board and approved by the Secretaries of Navy and War.

In order to carry out its missions a detailed policy and estimates have been drawn up. As far as appropriations have been available the plan has been carried out.

Battleships and cruisers are now operating aircraft from catapults.

The experimental carrier (U. S. S. LANGLEY) has been operating successfully, including flight operations with the various types of naval planes. The U. S. S. SARATOGA, modern aircraft carrier, was launched last April.

The Navy is now operating some 140 planes with the Fleet, and this number is gradually increasing.

There has been organized and maintained a highly efficient Marine Corps Aviation organization for expeditionary work.

The SHENANDOAH, designed, built and manned by the U. S. Navy, has cruised over 25,000 miles, including crossing the continent to the North West Pacific Coast and return to Lakehurst. Further she and the LOS ANGELES have successfully moored to the mast on the PATOKA. The PATOKA'S mast is the only mobile mast in existence and the idea of it originated with the U. S. Navy. During the present summer the SHENANDOAH has conducted a series of experiments with the battleship TEXAS at sea, including towing targets for the antiaircraft battery of the TEXAS.

Accidents have been reduced by careful regulation and inspection.

In addition to an organization for the regular Naval aviation organization, the Bureau has drawn up a complete organization for reserve Naval Aviation based on the thirteen Naval Districts and with money available has established four reserve aviation operating units.

It should be remembered that the operations of aircraft at sea are absolutely dependent on surface ships for their effectiveness. Ships of the Navy as bases for the operations of aircraft have given mobility to air operations that could never be obtained by the use of shore bases exclusively.

Recently we have heard radical theories expounded "that the day of the surface ships is done—that aircraft will take their place." To act on this principle, to decrease or to wipe out our fleet and to place our sole dependence in aviation would be national suicide. Experience in aviation has taught me its tremendous possibilities as an arm of the Fleet. On the other hand, I am convinced of the total inadequacy of aircraft alone as a means of national defense. We might defend ourselves against attack directed at our shores by the use of aircraft alone if we were content to remain on the defensive, and to supinely await attack, instead of taking the offensive. However, if we place our sole reliance in aviation we must surrender at once our ocean borne commerce, give up all hope of defending our island possessions, and submit helplessly to a process of economic starvation. Goods are still carried in surface vessels, will be in time of war, and must have aircraft and surface craft to protect them.

Aviation in the Navy as developed today and projected for the future will operate several thousand miles at sea, from ships of the Fleet. The first shot fired in the next naval battle will be an airplane shot from the deck of a surface ship and the battle in the air for air supremacy will be preliminary to the surface engagement which must be the final and conclusive argument. It is clear then that the Fleet, lacking the means to gain air supremacy, operates under a fatal handicap. It is just as clear that air supremacy in a naval engagement can never be anything more than a means to an end. It can only be a preliminary to the conclusive action fought out by surface ships.

The Navy in the air and the Navy on the sea is the strongest assurance of national security.

Antiaircraft Ordnance—Yesterday, Today and Tomorrow

By

MAJ. G. M. BARNES, ORD. DEPT. U. S. A.

THE history of antiaircraft artillery does not go beyond the period of the World War. At least no antiaircraft matériel of any consequence had been built prior to that time. During the first part of the war field guns were blocked up to give high angle fire and improvised mountings were used by both sides. New antiaircraft artillery was designed and put into production as soon as possible, so that toward the end of the war better types were available. At the same time great efforts were made to devise suitable fire control methods and instruments. Early systems were complicated and so slow in operation that the data were more or less useless when received at the guns. The first tendency was to use methods similar to those employed by field artillery against targets on the ground. These early systems were not very successful, due to the length of time required to compute the data. For example, the Italian Army used a clever manual plotting system which was very simple and ingenious, but with a target moving as fast as an airplane, it can be appreciated at once that systems requiring data to be computed by personnel, read off from charts and scales, shouted to the guns, laid off on scales on the gun carriages, etc., would never be suitable for directing the fire of antiaircraft guns against aircraft.

Also for the most part powder time fuzes were used. These early fuzes gave erratic results at the higher altitudes. Notwithstanding the crude fire control apparatus, powder fuzes, low velocity guns and improvised carriages, antiaircraft artillery fulfilled important missions in protecting troops, concentaration points, cities, etc., from aircraft. The records made with the antiaircraft matériel of the World War period are cited in the article by Major Mettler, page 76 of this issue.

In Fig. 1 is shown the 75-mm. antiaircraft truck mount. This is the unit which was extensively used by the French and also in part by the British and American troops. it was characteristic of the best antiaircraft matériel of the War period and it was with such guns that the records of the war previously referred to were made. This unit was constructed by mounting 75-mm. field guns on special auto trucks. Time would not permit the construction of special guns. It is now considered that such a gun is too low powered for antiaircraft fire. Our Army also has a number of very similar units built in the emergency by mounting American 75-mm. guns on White trucks. These units have been set aside for training purposes.

During the same period the Ordnance Department was hastening the construction of a large number of 3-inch antiaircraft guns of a more powerful type. When the Armistice came, many units had been completed and these now form the principal mobile antiaircraft matériel in the hands of our troops. This weapon is known as the 3-inch antiaircraft auto-trailer mount, Model of 1918.

The gun shown in Fig. 2 has a muzzle velocity of 2,400 feet per second when firing a 15-pound projectible, and is

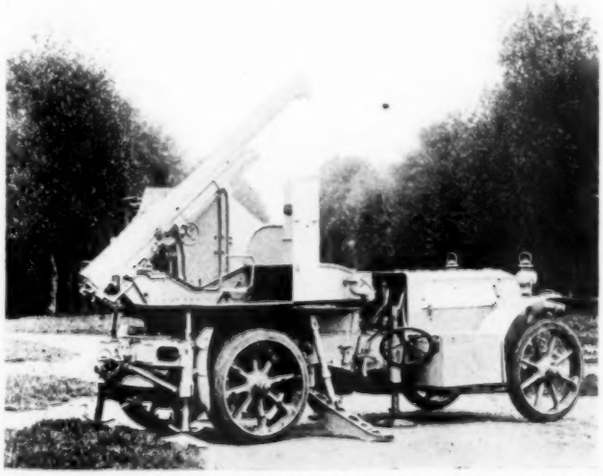


Fig. 1. French Antiaircraft Truck Mount. This mount is characteristic of the antiaircraft matériel of the World War period. It was constructed by mounting the French 75-mm. Field Gun on a special truck.

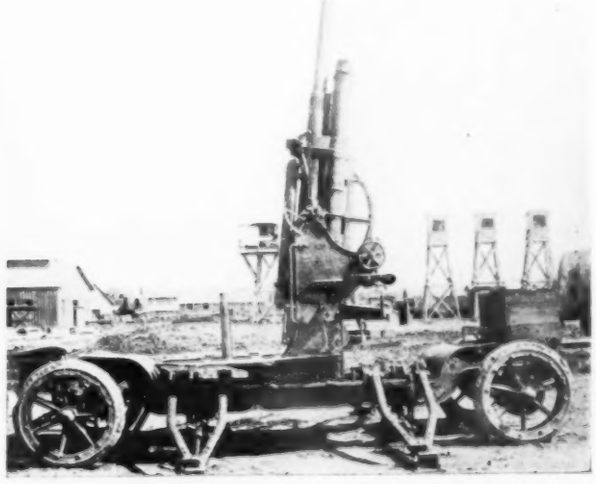


Fig. 2. 3-inch antiaircraft auto trailer mount, Model 1918. This is the type of gun now in service and is a distinct improvement over earlier types.

a distinct improvement over earlier types. This is the gun now being used for the antiaircraft tests held this season, the results of which are given later. This matériel is now seven years old. Antiaircraft defense is a new art which is being developed rapidly. These guns can therefore not be considered as modern. If funds were available, these weapons could now be replaced by antiaircraft guns many more times effective.

Fig. 3. Antiaircraft Data Computer, Model 1917.

Present Fire Control Equipment

The fire control equipment for these guns was built during the same period, and will be very briefly described in order to make more clear the great improvements in instruments for directing the guns, which are now in progress. Again it should be noted that all results obtained in target practice up to and including the season of 1925 have been made with the equipment about to be described. Doubtless several years will elapse before funds will be made available for equipping regular regiments with the newly developed apparatus.

The fire control equipment for each 3-inch antiaircraft battery of the 1918 matériel consists of the following instruments, in addition to the sight mechanisms on the gun carriages: 1—Data computer, Model 1917 (R. A.) (Fig. 3); 2—Altimeters, B′ & B″ instruments (Fig. 4); 1—Wind and Parallax Computer (Fig. 5); 1—Fuze setter for each gun.

These instruments were selected from the best, developed up to 1918.

At the present time the gun carriage is equipped with a telescope sight attached to the traversing part of the carriage by means of which the gun can be kept trained on the target.

The angle by which the gun must lead the target in the horizontal plane is set off on the horizontal deflection sight scale. The carriage is also equipped with an elevation disc actuated by the gun when elevated. By means of this mechanism the gun can be given the proper vertical lead and super-elevation.

The horizontal and vertical leads together with the proper fuze setting are computed by the data computer. (Fig. 3.)

This instrument is equipped with two telescopes, one of which is used for following the target in direction and the other for following the target in angle of site. If these telescopes are kept continuously trained on the target, the angular velocities in both planes can be measured. By multiplying these velocities by the time of flight of the projectile, the future position of the target can be obtained and the lateral and vertical angular displacements or deflections for setting the guns to the predicted position of the target computed. The fuze setting can also be determined.

Fig. 5. Wind and Parralax Computer.

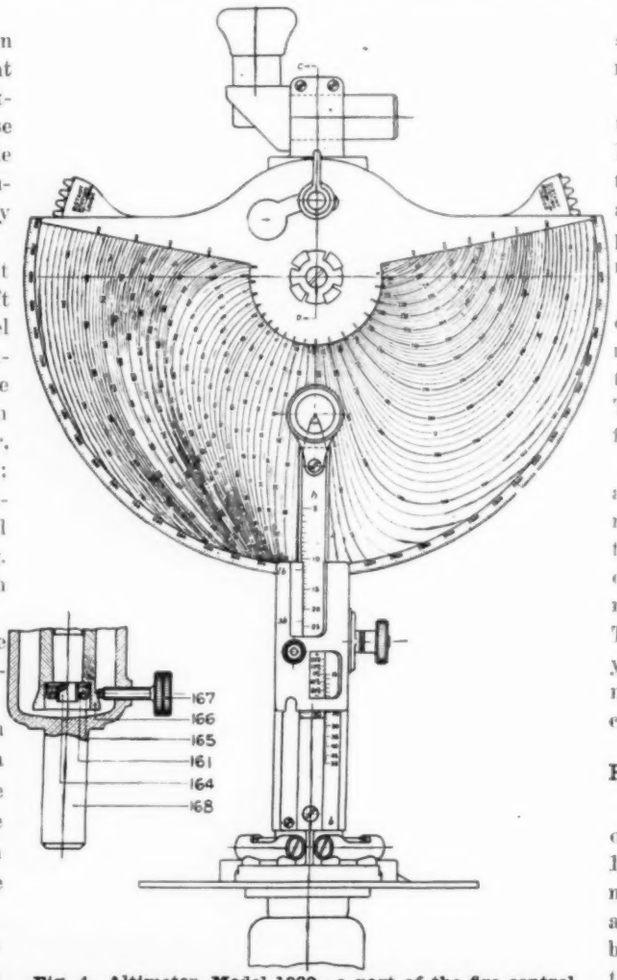


Fig. 4. Altimeter, Model 1920—a part of the fire control equipment necessary to determine accurately the altitude of targets.

These data are computed by this corrector which is of French design. The data obtained from this instrument are at the present time telephoned to the gun as soon as read from the instrument.

In order to compute the data indicated above, it is necessary to know accurately the altitude of the target. The altimeters supply this information. (Fig. 4.)

Two of these instruments are placed at the ends of a measured base line. The two telescopes are continuously directed at the target and reading taken simultaneously. The latitude of the target in yards is thus continuously measured and set into the corrector.

Recent Target Practice Results

The results which have been obtained during the season 1925 with the 3-inch A.A. gun, model 1918, and fire control, are interesting. It would not be possible to thoroughly cover these tests in an article of this length.

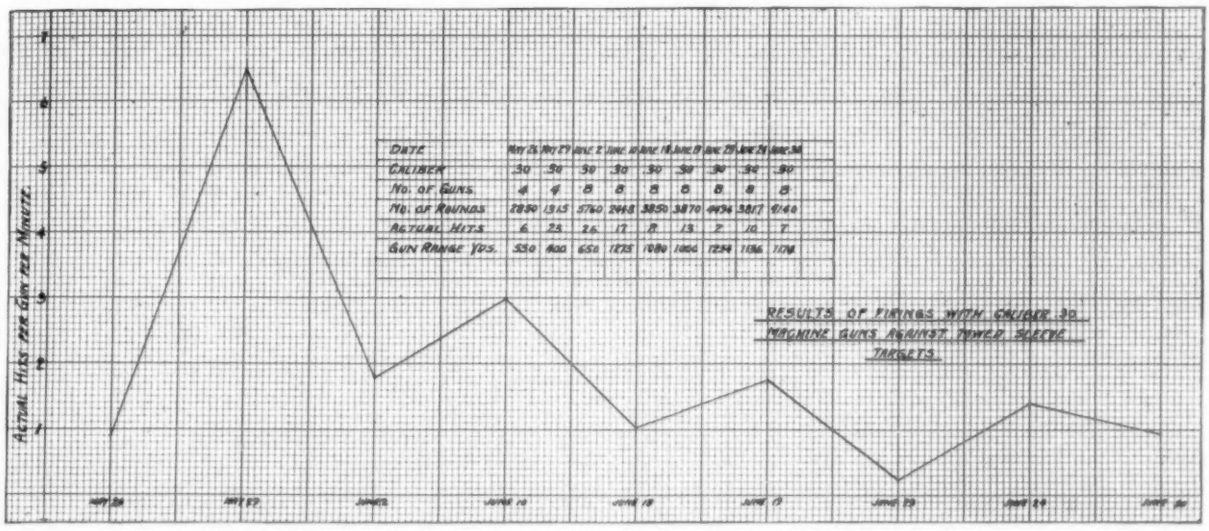


Fig. 6. Chart showing results of antiaircraft firing during a period of the 1925 season.

The table submitted below was selected at random and shows in a brief way the results obtained by one antiaircraft battery in firings held between May 22 and July 1.

Antiaircraft Artillery Practice Results

DATE OF FIRING	Hypo Hits	Actual Hits	Target (Recovered or Lost)	Ammunition Expenditure at T. T.	Record Preliminary or Test
May 22	None	None	Recovered	12	Preliminary
May 26	2	9	Recovered	52	Preliminary
June 2	2	None	Recovered	71	Preliminary
June 3	2	T. shot down	Lost	52	Record
June 4	4	?	Lost	79	Record
June 10	2	?	Lost	86	Test
June 17 and 18	6	11	Recovered	180	Record
June 22	6	?	Lost	65	Preliminary
June 22	8	10	Recovered	185	Record
June 24	4	17	Recovered	179	Record
July 1	11	4	Recovered	183	Record
	47	51		1144	

The third column gives the actual number of shrapnel holes found in the targets, while the fourth column shows those targets which were lost at sea and could not be recovered for the purpose of counting the holes.

The table shows that out of 11 targets used, one was shot down, five had four or more shrapnel holes each, four were lost at sea, and may or may not have had holes, while three targets showed no holes.

The records of this season's antiaircraft target practice, of which the above is a fair sample, have been very impressive, especially when it is known that such results have been obtained with guns, ammunition and fire control instruments now seven years old.

The target fired upon was a cloth sleeve in the form of a truncated cone 5½ ft. in diameter at the large end by 3½ feet at the small end and about 20 feet long. This target is towed by a bombing plane at the end of a 2,100 ft. wire. The target is about ¼ the size of a modern bombing plane which would have a wing spread of 74 ft. 2 inches, a length of 42 ft. 7 inches, and a height of 14 ft. 8 inches. The altitude of the target varied between a mile and a mile-and-a-half, while the horizontal ranges varied between 2 and 3 miles. At these altitudes this small target looks like a small speck and unless the day is exceedingly clear cannot be seen with the naked eye. On the other hand, the plane itself is plainly visible. It is hoped that it will eventually be possible to provide a larger target which can be seen more easily.

The second column of the table shows the number of hypothetical hits. To calculate hits other than those represented by actual holes, an observer rode in the towing plane and another was stationed on the ground, bursts above or below the target being watched by one and those ahead or behind by the other. Bursts are considered hits when they occur within 50 yards of the target as viewed from the ground, and within 35 yards short to 15 yards over as viewed from the plane.

Target Practice With Machine Guns

No mention has thus far been made of the use of machine guns. The caliber .30 machine gun is, however, one of the most important antiaircraft weapons. Due to the high rate of fire of 400 to 500 shots per minute, machine guns are very effective with their ranges.

The accompanying chart (Fig. 6) is based on results obtained this season. The target was a cloth sleeve similar to that used for the guns and was towed at a speed of about 75 miles per hour. At the end of each practice the holes in the targets are counted. The table shows the hits per gun per minute made by one battery for a period of several days.

Comparison of Antiaircraft Gun Ranges

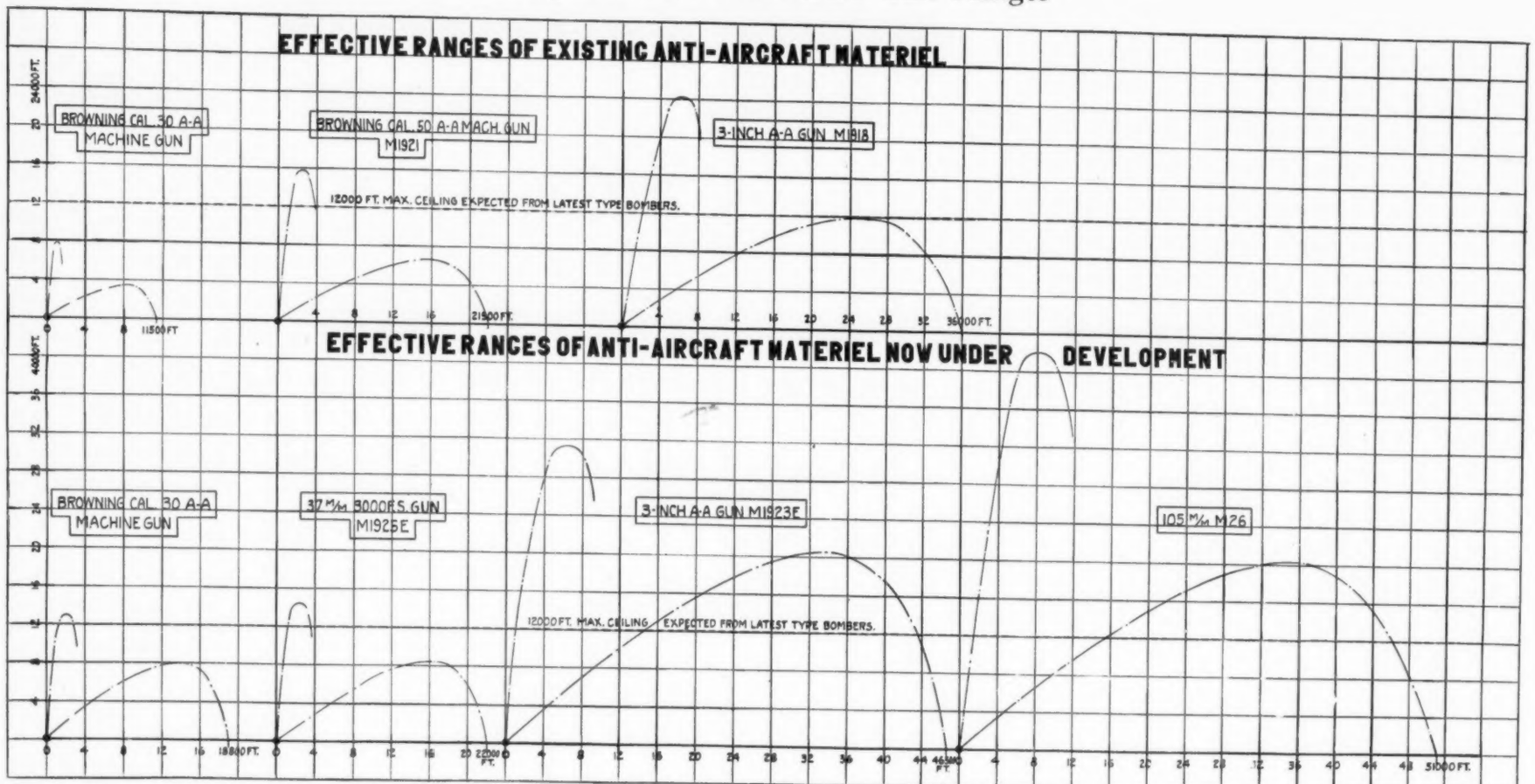

EFFECTIVE RANGES OF EXISTING ANTI-AIRCRAFT MATERIEL
BROWNING CAL. 30 A-A MACHINE GUN
BROWNING CAL. 50 A-A MACH. GUN M1921
3-INCH A-A GUN M1918
12000 FT. MAX. CEILING EXPECTED FROM LATEST TYPE BOMBERS.
11500 FT
21500 FT.
36000 FT.
EFFECTIVE RANGES OF ANTI-AIRCRAFT MATERIEL NOW UNDER DEVELOPMENT
BROWNING CAL. 30 A-A MACHINE GUN
37 M/M 3000 R.S. GUN M1925E
3-INCH A-A GUN M1923E
105 M/M M26
12000 FT. MAX. CEILING EXPECTED FROM LATEST TYPE BOMBERS.
18000 FT.
22000 FT.
46000 FT.
51000 FT.

Fig. 7. Diagramatic chart showing effective ranges of existing antiaircraft guns compared with ranges of new matériel now under development. Note that the ceilings of airplanes are well below those of the guns.

The Antiaircraft Problem

Before describing the developments of future antiaircraft artillery it is of interest to know what performance may be expected from future airplanes.

The table below gives the maximum speeds, ceilings, and rates of climb of various types of planes. Observation and bombing operations are usually carried out at altitudes well below the ceilings of the airplanes.

Type of Airplane	Max. ceiling height in ft.	Max. speed of airplane Miles per hour	Rate of climb Ft. per min.
Pursuit	27000	140 to 190	1500
Observation . .	18000 to 21000	110 to 160	750
Light Bomber . .	17000	90 to 120	
Heavy Bomber . .	12500	90 to 100	650

The ceilings, rates of climb, and maximum speeds given above are those which will probably be obtained with planes now under development, and should be considered in designing future antiaircraft artillery matériel.

Fig. 7 shows the effective ranges of our existing antiaircraft guns as well as those of the new matériel now under development. These data show that the ceilings of airplanes are well below those of antiaircraft guns.

Future Antiaircraft Matériel

In the post-war development of antiaircraft matériel, the following types of weapons are included: Cal. .30 machine guns and mounts; Cal. .50 machine guns and mounts; 37-mm. full automatic guns and mounts; 3-inch A. A. guns on mobile carriages; 3-inch A. A. guns on fixed carriages; 105-mm. A. A. guns on fixed carriages.

Machine Guns

That machine guns have an important place in antiaircraft defense is now becoming well established. The caliber .30 machine gun was used during the war for antiaircraft fire, but little was done towards developing special mountings or fire control instruments. The caliber .50 machine gun is a post-war development and will provide a gun with the high rate of fire of from 400 to 500 shots per minute, a more effective projectile, and a greater range.

Under the present scheme for firing machine guns, a vertical wall of projectiles is established just ahead of the plane, and this wall is maintained until the plane has passed through.

Special sights have been designed to permit the gunner to build this wall just ahead of the plane, and to inform him when the plane has passed the wall, so that he can continually repeat the operation.

Further developments will doubtless be in the direction of special fire control instruments for continuously measuring speed and range of target, and more refined sights.

Machine guns due to their great mobility will be relied upon to protect columns of troops on the march and general ground defense against low flying planes.

37-mm. Full Automatic Cannon

Experiments conducted at the Army proving ground have shown that the 37-mm. projectile when filled with high explosive and equipped with a supersensitive fuze is very destructive, and tests indicate that a single hit would probably effectively disable or bring down an airplane.

This has led to the development of a high powered full automatic machine gun of 37-mm. caliber. Experimental models of 2,000 feet per second and 3,000 feet per second muzzle velocities are being built. The rate of fire will be about 100 shots per minute with a projectile weighing 1¼ pounds. The projectile being developed for this gun will contain a high explosive charge and will be fitted with a supersensitive fuze designed to explode on contact with airplane fabric. The projectile will also have a tracer designed to burn for 10 seconds. The tracer should prove valuable in assisting the gunner to place his stream of fire on the target.

3-inch and 105-mm. (4-inch) Antiaircraft Guns

The principal improvements in antiaircraft guns have been in the direction of increased muzzle velocities, improved traversing and elevating mechanisms, and more stable and rigid carriages.

The 3-inch antiaircraft mount, Model of 1923-E, has been designed to eventually replace the 3-inch antiaircraft auto-trailer mount, Model of 1918 (Fig. 8). While the muzzle velocity and power of this gun have been materially increased, the total weight of the unit has been decreased. Similarly the 3-inch antiaircraft mount, Model 1917 MI (Fig. 9), will replace previously fixed antiaircraft mounts. The 105-mm. antiaircraft gun will provide a more powerful type.

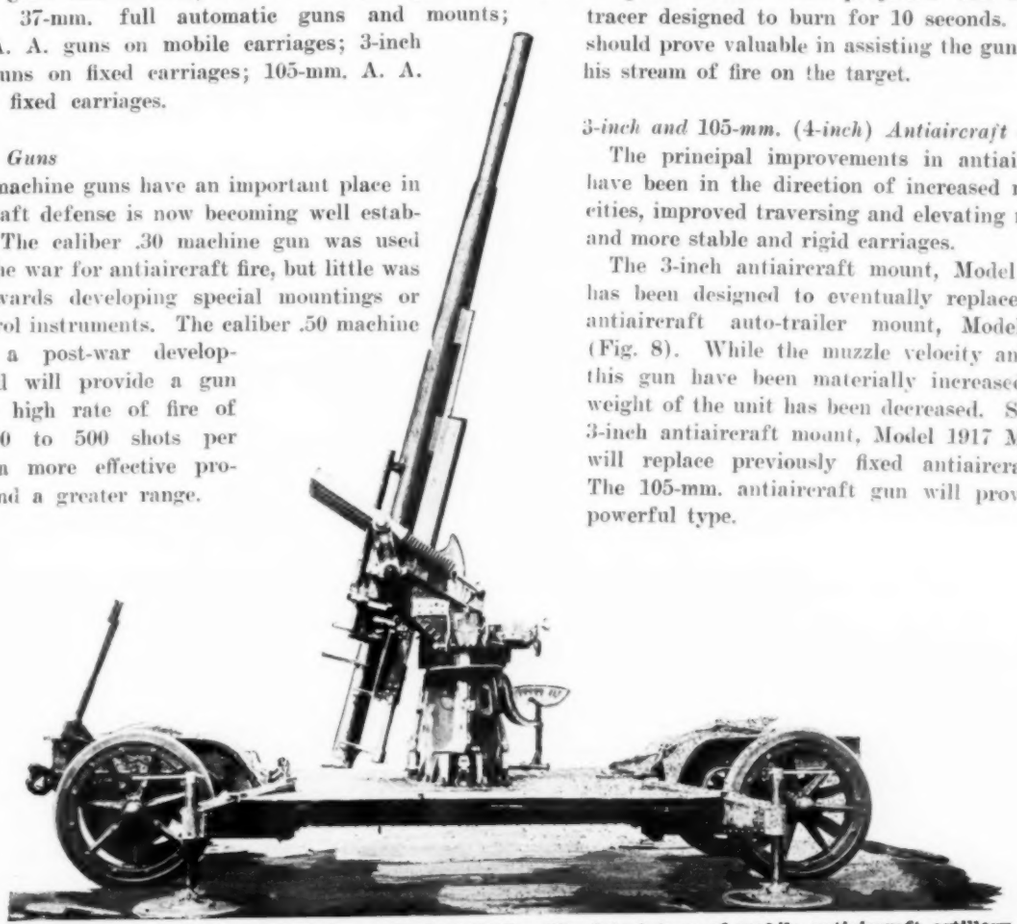


Fig. 8. 3-inch Antiaircraft Gun Mount, Model 1923 E. The latest type of mobile antiaircraft artillery.

Proposed New Fire Control Equipment

Time of Flight

Undoubtedly the most important single element in the antiaircraft problem is the time of flight of the projectile; that is, the time which elapses from the fire of the gun until the projectile reaches the point of burst. Time of flight is a very important element because firing data must be calculated to give the location of the airplane at the end of the time of flight. If the time of flight is long and the airplane is flying a curved course, the position of the airplane at the end of the time of flight may be entirely different from that expected. If, however, the time of flight is short, the plane will have less chance to change its path, and the predicted position of the target at the end of the time of flight will correspond more nearly with its actual position.

Another important time factor which must be added to the time of flight of the projectile is the so-called "dead time." The dead time includes the time between the determination of the fuze range and the firing of the gun. This is the time required for sending the firing data to the guns, setting deflections, fuzes, etc. The fire control instruments now in the hands of troops are designed for a dead time of 8 seconds.

It is evident that the time of flight and the dead time must be kept as small as possible. The time of flight can be reduced by the use of higher velocity guns and improved stream line projectiles. The muzzle velocity cannot, however, be increased indefinitely due to the rapid erosion of the guns at the higher velocities. At the present writing 2,600 to 2,800 foot seconds seems to be the maximum practical velocity for the 3-inch gun.

The dead time can be materially reduced by the use of automatic instruments for computing the firing data by transmitting data electrically and by the use of automatic fuze setters, etc. With such instruments it should be entirely feasible to reduce the dead time to 3 seconds for the 3-inch gun. These improvements in matériel should increase the effectiveness of antiaircraft matériel many times.

The trend of development in antiaircraft fire control is towards the indirect method. A diagramatic sketch of a battery of 3-inch antiaircraft guns, Model of 1923, is shown with the necessary fire control apparatus in Fig. 10.

The truck shown would be designed not only for carrying the fire control apparatus, but also for furnishing the electric power for data transmission and lighting. The chassis would therefore contain a small generator which could be clutched to the truck engine.

The altitude of the target would be continuously read by means of the stereoscopic height finder shown at the left [See Fig. 9], while the present azimuth and angle of site of target would be continuously measured by the telescope. These readings would go to the central station instrument in which all firing data would be automatically computed. This instrument would compute the future position of the target and would make such ballistic corrections for wind and muzzle velocity of gun as were necessary. The future azimuth, future angle of elevation, and future fuze number would be transmitted electrically to the gun, where these data would appear continuously on the proper dials. The gunners would have only to keep the gun continuously set for the predicted future position of the target by matching pointers. Fuzes would be set in an automatic fuze setter, the readings of which would continuously change in accordance with data from the central station instrument.

Fig. 9. 3-inch Antiaircraft Gun Mount, Model 1917 MI. The latest type of fixed antiaircraft artillery.

The principal advantages such a system of Case III method of fire control and automatic data transmission appear to be as follows:

(a) Reduction of dead time;
(b) No scales to read, and hence no errors of setting or reading scales;
(c) Data is continuous and not intermittent as at present; therefore each shot is fired on more accurate data.

Sound Listening Devices

The attack of airplanes from the ground at night presents new problems and requires additional apparatus. To locate accurately airplanes flying at high speeds in the dark, appears at first thought to be a problem, which is incapable of solution. Fortunately the difficulties are on both sides, as night bombing operations also present tremendous difficulties to the aviators in locating the target to be bombed. The airplane is located at night by means of sound apparatus. The latest type in use is shown in Fig. 11. By means of these horns of special design, an airplane can be picked up about 8 miles away. The horns give the location of the plane in terms of horiozntal angles and angles of site. Two or more sets of horns separated by known distances are usually employed, and the readings sent continuously to a central plotting board. The horn can be depended upon to give the position of the moving plane with an accuracy of about 1 degree. The plotting board computes the

Fig. 10. Diagramatic sketch of a battery of 3-inch antiaircraft guns, Model 1923, with necessary fire control apparatus and equipment.

necessary data for setting the searchlights. Since the beam of the searchlight is about 2 degrees wide, the data obtained from the horns is sufficiently accurate for placing the beam on the target. The latest type of searchlight can be controlled from a distant station or directly from the plotting room. When the airplane comes within range of the gun, several searchlights are snapped on,

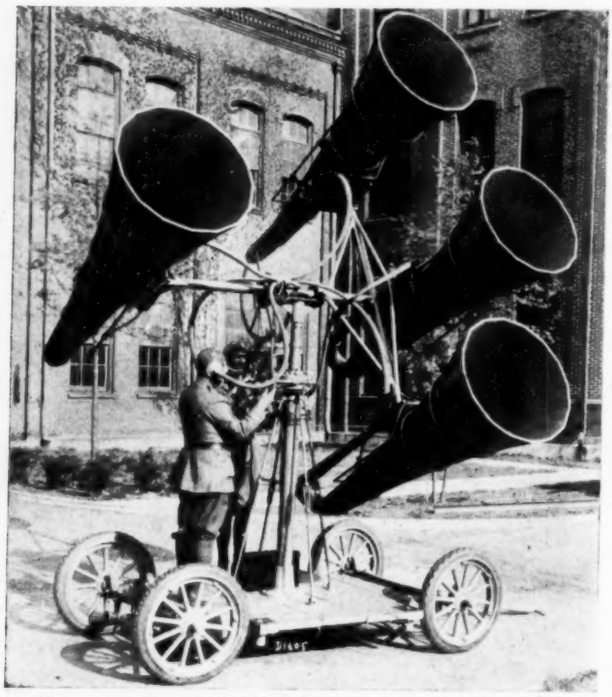


Fig. 11. Sound locating device for use in tracking airplanes at night.

and the plane illuminated. The guns can then fire by the same methods as are used for day fire.

New developments in sound locating apparatus will doubtless eliminate the plotting system and the horns will be interconnected with the searchlights through automatic instruments which will make the necessary corrections for sound lag, etc., and keep the searchlight continuously trained. It is also possible that sound apparatus may be developed so that the gun can be fired from the sound data without the use of the searchlights.

Imagine the moral effect upon an aviator flying a bomber in complete darkness, loaded with bombs containing high explosive, none too certain of his exact location, when suddenly caught in the searchlight beams and almost immediately surrounded by exploding shells. No one who has seen night exercises of this nature can believe that night attacks of planes against defended ground areas will be one-sided affairs.

To summarize, the writer believes that the antiaircraft artillery of the future will develop along the following lines:

(1) More extensive use of caliber .50 antiaircraft machine guns; further refinement of mountings and fire control.

(2) Extensive use of a large number of high velocity full automatic cannon on mobile mountings, firing high explosive shells of about 37-mm. caliber (1¼ lbs.).

(3) Higher velocity 3-inch and larger antiaircraft guns.

(4) Central station director for 3-inch and 4-inch antiaircraft guns which will accurately and automatically compute all firing data and deliver these data continuously to the gun.

(5) Electrical transmission of firing data for 3-inch guns and above from the central station instrument directly to dials on the guns, giving continuously future azimuth, future elevation, and future fuze setting, or in other words, all data required for Case III fire.

(6) Mechanical fuze setters, continuously set.

(7) More accurate fuzes for antiaircraft shells and more effective fragmentation of high explosive shells.

(8) More refined sound locators or other apparatus designed for detection of airplanes at night, sufficiently accurate to supply firing data directly to the guns without the use of searchlights.

It is believed that the majority of those who have followed the antiaircraft problem closely feel that the relatively slow-moving bombing airplane which must fly at relatively low altitudes and speeds will become an easy victim of the high-powered, rapid fire, automatically controlled antiaircraft artillery of the future.

THE ANNUAL CONVENTION OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION WILL BE HELD IN WASHINGTON, D. C., SEPTEMBER 29, 30, AND OCTOBER 1, 1925.

A SPECIAL FEATURE OF THE MEETING WILL BE A CONFERENCE ON THE RELATION OF MACHINE TOOLS, JIGS, DIES, FIXTURES AND GAGES TO INDUSTRIAL MOBILIZATION FOR WAR.

FOLLOWING THE CONVENTION THE MEMBERS OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION WILL PARTICIPATE IN THE SEVENTH ANNUAL MEETING OF THE ARMY ORDNANCE ASSOCIATION AT ABERDEEN PROVING GROUND, OCTOBER 2, 1925.

The Franklin Institute

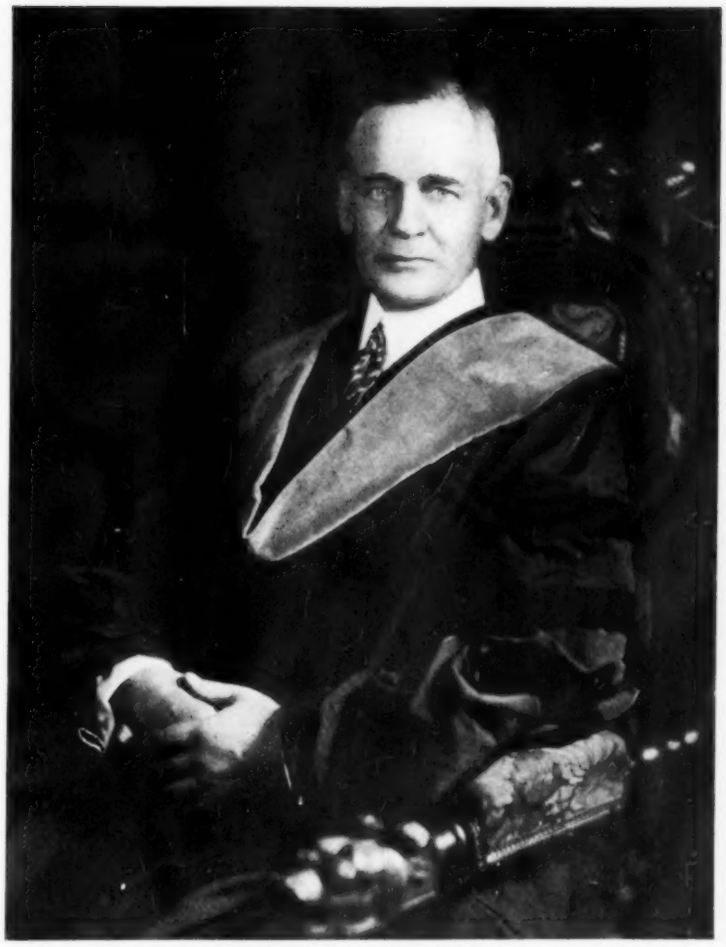
By

WM. C. L. EGLIN, Sc.D.

THE Franklin Institute owes its existence of more than a century largely to the untiring efforts of two young men: Samuel Vaughan Merrick, whose business career had just begun, and William Hypolitus Keating, a graduate of the University of Pennsylvania and professor of chemistry and mineralogy in that institution.

They extended invitations to fifteen hundred prominent citizens to attend a meeting on the evening of February 5, 1824, in the County Court House, Philadelphia, for the purpose of organizing a technical society. A constitution was adopted and a day fixed for the election of officers and managers.

On March 30th the State Legislature passed an act incorporating The Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts. The bill was signed by the Governor on the same day and the Institute took its place among the learned societies of the world.



William C. L. Eglin, Sc.D.
President, The Franklin Institute of the State of Pennsylvania.
Past President, National Electric Light Association.
Past Vice-President, American Institute of Electrical Engineers.
Vice-President and Chief Engineer, The Philadelphia Electric Company.
A pioneer in the American electric power industry.

The several standing committees speedily perfected their plans and the first course of lectures was inaugurated early in April, 1824, by Dr. Keating.

Schools

In October a drawing school was opened for members' sons and apprentices. John Haviland, an architect of note, was in charge and was assisted by Hugh Bridport, an artist and painter of miniatures. In later years the school was under the direction of Professor Lewis M. Haupt, a West Point graduate, and for some time professor of civil engineering at the University of Pennsylvania. At a still more recent period, for twenty-five years, it was in charge of Mr. William H. Thorne, an engineer actively engaged in his profession. Mr. Thorne was the first to plan and publish a systematic course of instruction for students of mechanical drawing. Thousands of copies of his texts were used in other technical and engineering schools, including the U. S. Military Academy at West Point. Today there are about one hundred textbooks of drawing, nearly all following the plan outlined in Thorne's volumes published in 1883.

This school was continued uninterruptedly for ninety-nine years. Classes were also formed in mathematics, naval architecture, machine design and related subjects and continued as long as there was a demand for such instruction.

In 1826 another school was established in which were taught "all the useful branches of English literature and the ancient and modern languages." Three hundred and four pupils were enrolled in the first term and the courses of instruction included English, French, Latin, Greek, Spanish, German, elocution, geography, drawing and mathematics. The school, with Walter R. Johnson as principal, was continued until 1832 and was the predecessor of the public High Schools.

The educational work of the Institute was conducted by the Committee on Instruction, consisting of five members of the Board of Managers. Among the many who have served on this Committee during the ninety-nine years of its existence may be named: Alexander Dallas Bache, grandson of Dr. Franklin, graduate of West Point, professor of natural philosophy and chemistry, University of

Pennsylvania, first president of Girard College, superintendent of schools, Philadelphia, superintendent, U. S. Coast and Geodetic Survey, etc.; Matthias W. Baldwin, inventor, builder of the first locomotive in Philadelphia; John C. Trautwine, civil engineer, builder of railroads; John F. Frazer, physician, lawyer and author, professor of nautral philosophy and chemistry, University of Pennsylvania, and, for some time, vice provost; Robert E. Rogers, civil engineer and physician, professor of chemistry, University of Virginia, University of Pennsylvania, Jefferson Medical College; John H. Cooper, mechanical engineer, authority on belting; Henry Morton, chemist, president, Stevens Institute of Technology; and Frederick Graff, civil engineer, who succeeded his father as chief engineer of the water works of Philadelphia in 1847, serving until 1856, reappointed in 1866 and continued in office until 1872, when he declined a further reappointment.

The Building Erected by The Franklin Institute in 1825 at Philadelphia.

The Cornerstone was laid June 8, 1825: John Haviland was the Architect. The building is occupied today by the Institute and houses one of the largest and most important technical libraries in existence.

"Hic domus ubique fama"

Exhibitions

With a view to encouraging domestic industry exhibitions were held periodically, the first on October 18, 19 and 20, 1824. On this occasion there were about three hundred exhibits and premiums were offered for such domestic products as blister steel, bar iron, broadcloths, carpets, etc. These exhibitions were held yearly or biennially until 1858, and were only abandoned at that time for the want of a centrally located building.

In 1874, the fiftieth anniversary of the Institute's founding, the management was fortunate in obtaining, from the Pennsylvania Railroad Company, permission to use for exhibition purposes an old freight station at Thirteenth and Market Streets. Here was held, in October, the most successful exhibition of its kind ever conducted up to that time. There were 1251 exhibitors and 267,638 paid admissions.

The most brilliant and perhaps the most important exhibition—the International Electrical Exhibition—was held ten years later in West Philadelphia. Again the Pennsylvania Railroad Company generously placed at the disposal of the Institute a railroad station and plot of ground upon which was erected a suitable building. This exhibition—the first in the United States devoted solely to electrical appliances—was opened on September 2, 1884, and continued for six weeks. There were approximately 216 exhibitors, and the receipts from the sale of tickets totalled $98,639.70.

By an Act of Congress passed in May, 1884, which was duly approved by the President, the United States Electrical Commission was created. This body was authorized to conduct a national conference of electricians during the continuance of the exhibition. The act further provided that the commission thus appointed might invite scientific men, native and foreign, to participate in the conference. The president of the commission was Professor Henry A. Rowland of Baltimore. In the list of foreign conferees appear the names of William Thomson, James Dewar, Oliver J. Lodge, W. H. Preece and Silvanus P. Thompson. The American conferees included Alexander Graham Bell, C. F. Brackett, Bradley A. Fiske, Elisha Gray, A. W. Greely, E. W. Rice, W. T. Sampson, Elihu Thomson, and Edward Weston. At this conference, which covered a period of six days, the question of establishing a uniform system of electrical units was considered for the first time. The recommendations of the conference of the definitions of the units of electrical measurement were subsequently influential in the establishment of the electrical units by international congress.

Immediately after the exhibition a most complete and extended series of tests was made to determine the characteristics of the more important types of electrical apparatus and appliances. The reports on the efficiency and life-duration of incandescent electric lamps and those on the dynamo-electric machines were of permanent value to the electrical industry.

The last exhibition under the auspices of the Institute—The Novelties Exhibition—was held in the following year, and consisted of exhibits of American manufactures.

In the fall of 1899 The National Export Exposition was conducted jointly by the Commercial Museum of Philadelphia and the Institute.

The influence of the early exhibitions on American manufactures was incalculable. There is scarcely an industry which has not profited, directly or indirectly, by the encouragement and impetus given it by the Institute.

David Spillane's "History of the American Pianoforte, its Technical Development and Trade," published in 1890, is dedicated as follows: "To The Franklin Institute of Pennsylvania, which has exercised such a potent influence upon the early history of the American pianoforte and kindred arts, this work is respectfully dedicated."

The late James M. Swank in his "History of Iron in All Ages" also expresses his appreciation of the value of the Institute's exhibitions.

Journal

In August, 1825, announcement was made that the

Institute would shortly publish The Franklin Journal and Mechanics Magazine. The object of this publication as defined in the prospectus was "to diffuse information on every subject connected with useful arts." The early numbers contain detailed descriptions of useful inventions and improvements, especially those patented in the United States, and these accounts are accompanied by remarks on the utility and originality of such inventions. The transactions of the Institute as well as the lectures delivered in its Hall and special contributions form the contents of the volumes.

Dr. Thomas P. Jones was the first editor of the Journal. He was also professor of mechanics and Recording Secretary of the Institute. He was appointed Superintendent of the Patent Office in April, 1828, and while this necessitated his removal to Washington, he continued his active relations with the Journal until the time of his death in 1848.

Library and Reading Room of the Institute from 1875 to 1885.

The Journal has continued uninterruptedly since January, 1826, and is now in its one hundredth year. There are twelve numbers a year divided into two volumes, each with title-page and index. Copies of the Journal may be found on file in the libraries of all the technical and scientific societies of the world including those in Iceland, Japan, India and Australia.

Monthly Meetings

The general meetings of the Institute's entire membership, which occur once a month from October to April, are also a feature which is not duplicated by any other society. At these meetings great inventions and discoveries, important engineering projects and notable achievements in all fields of scientific progress are presented, exhibited and discussed.

Most of the epoch-making inventions have been shown in the Hall of the Institute in their experimental stages.

At the meeting of May 16, 1888, Mr. Emile Berliner of Washington gave the first account of his gramophone—the instrument which has since become famous as the Victor Talking Machine.

The Bardwell Votometer, an apparatus which records votes and dispenses with the services of the great number of officials at the polls on election days, was exhibited in operation on February 16, 1901.

A system of automatic telephony in working operation was exhibited on January 21, 1909. Telephones were placed in various parts of the building and the mechanism which takes the place of the human operator was on the lecture-room floor in a glass case, thus enabling those present to "see the wheels go around."

Several years ago a demonstration of transcontinental telephony was given. Each chair in the lecture room was supplied with a receiver and those present were able to listen to conversations by the chairman and others with those of the members who resided in San Francisco.

The telephone, the phonograph, the electric light, the typewriter, liquid air apparatus, machine telegraphy, radio-telephony and telegraphy, "wired wireless" have all been exhibited at meetings of the Institute.

Library

A Committee on Library was appointed April 1, 1824, and the first collection of books was stored in the home of a member of the committee. On July 23, 1830, a reading-room was opened for the first time, the hours being from three until ten o'clock P. M. In 1838, 142 volumes were purchased, 126 volumes were received by gift and 48 by exchange. In 1875 the library consisted of 11,000 volumes and in 1900, 48,000 volumes and at the present time the collection is made up of 82,940 volumes, 20,655 pamphlets and 4,432 maps, charts, drawings and photographs.

The library is devoted entirely to works on technology. The reports of the patent offices of several nations form an important department. The complete specifications of the patents of Great Britain are on the shelves, beginning with the first patent granted in 1617 and continuing to date, the reports of the United States Patent Office are on file from 1790 to date, the Swiss reports can be also consulted, the first being dated 1888. The French specifications are accessible from July 20, 1791, to July, 1900. Abstracts of patents of Germany, Austro-Hungary, Canada, Australia and New Zealand are also available.

There are sets of all the important technical magazines and society transactions, about 1800 in number. To name them here would be impossible, but the following are a few of the more important ones which are complete and bound: Engineer; Engineering; Engineering News; Genie Civil; Iron and Steel Institute, publications; Revue Generale de Chemins de Fer; Zeitschrift des Vereins Deutscher Ingenieure; Stahl und Eisen; Annalen der Physik; Liebig's Annalen; Philosophical Transactions of the Royal Society of London; Philosophical Magazine, etc.

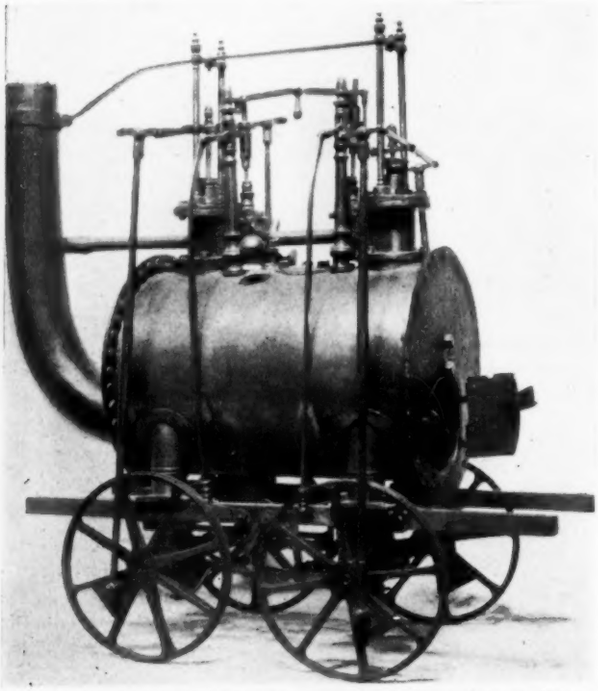
The library also receives by gift the numerous technical publications of a miscellaneous character from state and municipal authorities and corporations including reports on public works, agriculture, health, municipal engineering and transportation.

An excellent collection of the reports of the several state railroad commissions is on file as are also the reports of the state geologists. The publications of the water de-

partments of many cities and towns throughout the United States are also collected. The library contains a great many works relating to chemistry, electricity, metallurgy, geology, and the several branches of engineering.

While no systematic effort has ever been made to obtain early printed books or literary treasures the Institute is proud of the few which it does possess. The following are sufficiently interesting to note here:

The Works of the Highly Experienced and Famous Chymist, John Rudolph Glauber. Translated into English by Christopher Packe, folio, London, 1689.



Model of George Stephenson's "No. 1" Locomotive, Built for the Stockton and Darlington Railroad. Brought from England by William Strickland in 1826.

The Art of Distillation by John French, 12mo., London, 1667.

A Description of the Machines Invented by Captain Ramelli. (In Italian and French) Paris, 1588.

Experiments upon Magnesia, Alba, Quick-lime and other Alcaline Substances by Joseph Black, M. D., to which is annexed an essay on the Cold Produced by Evaporating Fluids, and on some other means of Producing Cold by William Cullen, M. D., 16mo., Edinburgh, 1782.

A Philosophical Account of Nature in General and of the Generation of the Three Principles of Nature, viz.: Mercury, Sulphur, and Salt out of the Four Elements. Translated from the French by John Digby, Esq., 348 pages, 12mo., London, 1722.

An Essay on Phlogiston and the Constitution of Acids. A new edition, by R. Kirwan, Esq., 317 pages, 8vo., London, 1789.

A work on astrology published in Dresden in 1669 which describes the making of sun dials and gives the horoscopes of such well-known persons as Noah, Moses, Hercules, etc., and the longitude and latitude of 500 principal cities.

Committee on Science and the Arts

A branch of the Institute's work of which no counterpart is to be found in any other organization is its Committee on Science and the Arts. This body was at first known as the Board of Examiners and later as the Committee on Inventions. It has been active under its present title since 1834. This Committee examines and reports upon all new inventions that may be submitted to it and where sufficient merit is shown recommends the award of a medal or a certificate of merit. During its period of activity over 2,800 inventions, devices and processes have been examined. The following medals are at the disposal of the Committee and are awarded on its recommendation:

The Franklin Medal (Gold Medal and Certificate). This medal is awarded annually from the Franklin Medal Fund, founded January 1, 1914, by Samuel Insull, Esq., to those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the Institute, acting through its Committee on Science and the Arts, have done most to advance a knowledge of physical science or its applications.

The Elliott Cresson Medal (Gold Medal and Certificate). This medal, founded in 1848, is awarded for discovery or original research, adding to the sum of human knowledge, irrespective of commercial value; leading and practical utilizations of discovery; and inventions, methods of products embodying substantial elements of leadership in their respective classes, or unusual skill or perfection in workmanship.

The Howard N. Potts Medal (Gold Medal and Certificate). This medal, founded in 1906, is awarded for distinguished work in science or the arts; important development of previous basic discoveries; inventions or products of superior excellence or utilizing important principles; and for papers of especial merit that have been presented to the Institute and publishd in its Journal.

The Louis E. Levy Medal (Gold Medal and Certificate). This medal, founded in 1923, is awarded to the author of a paper of especial merit, published in the Journal of The Franklin Institute, preference being given to one describing the author's experimental and theoretical researches in a subject of fundamental importance.

The George R. Henderson Medal (Gold Medal and Certificate). This medal, founded in 1924, is awarded for meritorious inventions or discoveries in the field of railway engineering.

The Edward Longstreth Medal (Silver Medal and Certificate). This medal, founded in 1890, is awarded for meritorious work in science or the arts. In the event of an accumulation of the fund for medals beyond the sum of one hundred dollars, it is competent for the Committee on Science and the Arts to offer from such surplus a money premium for some special work on any mechanical or scientific subject which is considered of sufficient importance.

The Franklin Medal has been conferred upon the following scientists during the past eleven years: Svante August Arrhenius, 1920; John J. Carty, 1916; James Dewar, 1919; Thomas Alva Edison, 1915; Charles Fabry, 1921; Auguste Gustave Ferrié, 1923; Hendrick Antoon Lorentz, 1917; Guglielmo Marconi, 1918; Thomas Corwin Mendenhall, 1918; Albert A. Michelson, 1923; Ralph Modjeski, 1922; Heike Kamerlingh Onnes, 1915; Charles Algernon Parsons, 1920; Theodore Wm. Richards, 1916; Ernest Rutherford, 1924; Frank J. Sprague, 1921; George Owen Squier, 1919; David Watson Taylor, 1917;

Elihu Thomson, 1925; Joseph John Thomson, 1922; Edward Weston, 1924, and Pieter Zeeman, 1925.

The first Creeson award was made to General Benjamin Chew Tilghman of Philadelphia, the discoverer of the application of the sand blast for a variety of useful and ornamental purposes. Others who have received this recognition are: Alexander Graham Bell, Pierre and Marie Curie, Lee DeForest, P. B. Delany, R. Diesel, John Fritz, Robert A. Hadfield, Auguste and Louis Lumiére, M. I. Pupin, Lord Rayleigh, W. C. Roentgen, Nikola Tesla and Harvey W. Wiley.

Lectures

Since the first course of lectures was opened in April, 1824, many changes have taken place in the demand for such instruction. For many years the lectures were of the nature of a regular course, or series, on architecture, mechanics, physics and chemistry. This system, however, was found in time to be gradually outgrowing its usefulness and so it was found advantageous to modify the plan in order that the members of the Institute might have the opportunity of listening to accounts of the latest advances in the useful arts and the sciences bearing thereon by men of eminence in their respective fields of labor.

Lectures are now given weekly on scientific and technological subjects of immediate interest to the public and germane to the topics of the day.

Museum

The Committee on Museum has always been very active. During the century a number of valuable and unique pieces of historic apparatus and models have been obtained from friends of the Institute.

Within two years after its founding Dr. John Redman Coxe presented a cylinder electrical machine, once the property of Dr. Franklin; later his table for dressing type, a piece from his printing establishment, was presented by Prof. Franklin Bache, and in 1898 the dress sword worn by Dr. Franklin while at the court of France was added to the collection by Dr. R. Meade Bache. The museum also contains Dr. Priestley's air pump, brought by him to America in 1794; a magneto-electric machine made by Dr. Joseph Saxton, and exhibited before the British Association for the Advancement of Science in 1833; Phelps' printing telegraph apparatus; models of Oliver Evans' "Columbian" high pressure steam engine made by Rush and Muhlenberg; George Stephenson's "No. 1" locomotive built for the Stockton and Darlington Railroad; the Reidheifer "perpetual motion" machine and the Keely motor.

Bartol Laboratory

In 1921 the Institute received a bequest of $1,208,468 from the late Henry W. Bartol, a life member of the Institute, for the purpose of conducting researches relating to fundamental problems in physical science, particularly those in the field of electricity and for the investigation of specific problems of a scientific nature which may arise in the industries.

The Institute owns at Nineteenth Street and the Parkway a large property which has been acquired for the future needs of the Institute. A number of dwelling houses now stand on this site. Three of these houses have been remodelled and equipped as physical laboratories. An admirable machine shop has been equipped. A generous provision of motor generator sets, dynamos and storage batteries has been installed. An adequate supply of standard apparatus required in physical research has been purchased and special pieces of apparatus required by particular researches are already in course of construction. Fellows of the general standing and character of the National Research Fellows are expected to carry on research work in physics and allied sciences and to make

Model of the Reidheifer "Perpetual Motion" Machine. This model was made by Isaiah Lukens, first Chairman of the Committee on Science and the Arts. It was built for the purpose of exposing the fraudulent nature of the claim of Charles Reidheifer to have discovered a self-acting machine for the investigation of which the Legislature of Pennsylvania in December, 1812, appointed a commission of experts. Oliver Evans was a member of this commission. The original Reidheifer machine was operated by means of a crank. The model illustrated is operated by clockwork concealed in the base.

of this great research foundation a fruitful source of scientific investigation. It is now expected that the research work will be inaugurated in the autumn of the present year.

Centennial

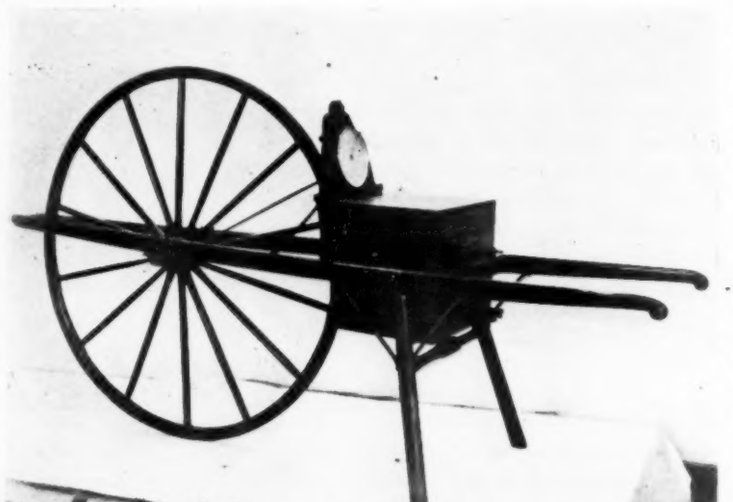
A year ago the membership celebrated the one hundredth anniversary of the founding of the Institute and the inauguration of the Bartol Research Foundation. The program consisted of a series of addresses, a garden party and a banquet. Invitations were extended to all learned societies, universities and industrial organizations throughout the world and about three hundred delegates were present.

The guests assembled in the Hall of the Institute on Thursday morning, September 17th, and proceeded to the Walnut Street Theatre, where the opening ceremonies were held. The delegates were welcomed by the Mayor of Philadelphia and listened to an historical account of the Institute's activities by Dr. Elihu Thomson, Chairman of the Honorary Committee on the Centennial Celebration and for fifty years a member of the Institute.

The several technical meetings at which forty-eight papers were read were held in the Hall of the Institute, at the University of Pennsylvania and the hall of the Academy of Natural Sciences on Wednesday afternoon, Thursday morning and Friday. On Thursday evening Sir Ernest Rutherford, Kt., D.Sc., of Trinity College, Cambridge, addressed an audience of over one thousand on "The Natural and Artificial Disintegration of the Elements."

On Friday morning, September 19th, a tablet was unveiled in the buildings of the Bartol Research Foundation commemorating the bequest of Henry W. Bartol.

The proceedings were brought to a close by a banquet on Friday evening at which about five hundred persons were present. The memorial scrolls and greetings were handed to the President by the delegates from the numerous institutions and societies. Brief addresses were made by Professor Charles Fabry, Paris; Sir Ernest Rutherford, Cambridge; Dr. Pieter Zeeman, Amsterdam; Dr. Fritz Haber, Berlin; Dr. Olaf Lamm representing Sweden; Sir Charles and Lady Parsons, Sir William and Lady Bragg, and Dr. Josiah Penniman, president and provost of the University of Pennsylvania, and Dean Howard McClenahan of Princeton University.



Another Franklin Institute Relic.
Lesley's odometer used in connection with the work of the Second Geological Survey of Pennsylvania.

Public Work

The Franklin Institute has always taken an active part in public work and brief mention of the most important undertakings follows:

In 1829 an investigation was begun to ascertain the efficiency of moving water as a motive power. Seven hundred experiments were performed with water wheels of all types and the results of these many tests were published during the years 1831, 1832 and 1841.

The committee on the explosion of boilers on steamboats was already engaged in its inquiry when the Secretary of the Treasury of the United States requested that the further extension of the Institute's inquiry include the prevention of steamboiler explosions. Six years were spent on this problem.

The Legislature of Pennsylvania requested a report on the weights and measures of the State. A committee of seventeen made an extensive and detailed report and superintended the construction of the standards on which the present laws of the State are based.

A joint committee of The Franklin Institute and the American Philosophical Society began systematic meteorological observations in aid of agricultural and other interests in 1834. This service was continued for several years.

In 1843 City Councils of Philadelphia requested information on the best modes of paving highways. A voluminous report was soon prepared describing the best construction of asphalt, wood and stone pavements with suggestions for pavements especially suited for Philadelphia.

In 1863 the Guardians of the Poor requested the Institute to communicate to them the most efficient means of protecting the almshouse buildings from lightning. A survey of the ground and buildings was made and detailed directions were given for the installation of a system of lightning rods, properly connected and grounded.

In 1864 a special committee was named to consider the question of adopting a uniform system of screw-threads, bolt-heads and nuts. After many conferences, much correspondence and with the cooperation of several departments of the government, the railroads throughout the country, the engineering societies and the machine shops, certain forms and proportions were adopted and recommended for general use. These standards were adopted by the government in 1868, by the Pennsylvania Railroad Company in the following year and were approved by the Master Car Builders' Association in 1872.

The solar eclipse of 1869 was observed at Mount Pleasant, Iowa, by a commission organized by the Institute.

The modes of determining the horse power of steamboilers were investigated by a special committee which presented its report in 1872.

In 1875 and again in 1882 the Institute was invited to coöperate with the Water Department of Philadelphia in investigating the water supply of the city, the prevention of its pollution and possible sources of future supply.

This then is the account of some of the activities and accomplishments of The Franklin Institute during the past one hundred years. What the future may bring is beyond our ken. We can only repeat the closing remarks of Professor Robert E. Rogers' address at the Semicentennial Celebration of the Institute on February 6, 1874: "With such a record of the past, may not our Institute anticipate yet brighter prospects in the future, and should we not all exclaim in earnest words, *'Esto Perpetua'*"?

All Phases of Ordnance Studied By Reserve Officers at Aberdeen Training Camp

THE Riffians were not the only warriors who, during the torrid month of August, suffered from the grueling effects of war. There was another band of hardy soldiers who prepared themselves for an imaginary enemy for fifteen days on the plains and in the workshops of the Aberdeen Proving Ground at the Second Annual Reserve Officers' Training Camp which was held from August 2nd to 16th.

Under the genial command of Maj. C. H. Bandholtz, ordinarily a Major, Ordnance Department, of a congenial nature, but in "war time" a strict and formal disciplinarian, the civilian soldiers were put through the paces of a training camp, the like of which, all the trainees are willing to wager, has never been equalled, much less surpassed. For enthusiasm, spirit and educational value, this Reserve Officers' Training Camp was a magnificent success, a great credit to the Ordnance Department, the officers at Aberdeen, and, of course, to the Director of Training and his assistants. When taps were sounded on the last day of training there was not one Reserve Officer at the Camp who did not regret that the grueling days of study and work were over, and who would not have continued on with all the enthusiasm of the first day.

To begin with, Aberdeen Proving Ground is probably the most ideal ordnance establishment at which to hold a Reserve Officers' Training Camp. Here are located facilities and equipment unrivaled anywhere else in the country. The widest possible latitude in the study of ordnance subjects is afforded because at Aberdeen are available types and examples of every conceivable kind of ordnance—past, present and future. When one considers that on the reservation alone there are 35 miles of railroad, and that often times classes are held at the end of the 35th mile, a clear idea can be gotten of the tremendous size of the place and of the large scale on which all the activities are carried out.

The course of training could not have been more enterprisingly arranged nor more thoroughly conducted. True, it is a difficult task for one to master, for instance, the highly involved topic of antiaircraft in a three-hour period, or to digest the whole topic of railway artillery from its earliest beginings to date in one morning. Nevertheless, the trainees went at all of their assignments with a will, and this, together with the patient and considerate attitude of the instructors, made all the courses entirely worth while. Add to this the fact that every lecture and instruction was covered to an infinitesimal degree by a series of questions which one must answer in full, said answers to be written some time between 3:30 P. M. and taps, or face court-martial, and you have an accurate idea of the strenuous days of the Camp.

In chronicling here the outstanding events of the Camp, too much praise cannot be given Major Bandholtz, Director of Training, who was in charge; Capt. H. L. Campbell, who was the Director's right-hand man, and Capt. L. M. Bricker, whose efforts in feeding the hungry warriors rivaled the palmiest days of the Brick-house Mess at old Sandy Hook. Then, too, Capt. D. C. Kelly, Lt. G. C. Woodbury, and Lt. F. C. Shaffer helped considerably by being on the job from sunrise to sunset and by giving counsel and assistance at all times.

Now a word about camp life. The Reserve Officers were housed in comfortable barracks although very little of their time was spent in them. Up at 5:30 each morning, with a period of calisthenics on the athletic field promptly at 6, the day began with a rush. Breakfast was followed by an hour of infantry drill at 7, and by 8 o'clock—when nearly everyone felt it must surely be about supper time—classes were ready to start continuing until 12. At 1 classes were again resumed and concluded at 3:30. There was then a brief respite when all forms of athletics could be engaged in whereupon the golfers took to the well-kept course at the Proving Ground, the swimmers to the diving float in Chesapeake Bay, and the card-sharks to the recreation room—each to his own kind of relaxation. This was the routine that was followed throughout the entire Camp.

Brig. Gen. C. L'H. Ruggles, Acting Chief of Ordnance, visited the Camp on Thursday, August 13th, and made a personal tour of inspection of the several sections at their various places of instruction and also addressed the entire company. He praised the officers for their public spirit and active coöperation in preparing to help the Ordnance Department carry on its important mission.

For all military formations the trainees were divided into three platoons, while for class and instructional purposes they were grouped in eight sections.

The subjects for the various classes and instructors were as follows:

Organization of the Proving Ground, Capt. G. S. Kennedy.

Mobile Artillery, Lt. R. Z. Crane and Lt. L. C. Leonard.

Artillery Ammunition, Capt. E. E. MacMorland.

Pistol Marksmanship, Lt. T. H. Nixon.

Fire Control Instruments, Capt. G. S. Kennedy.

Small Arms and Machine Shop, Capt. T. M. Jervey and Lt. L. S. Lindsey.

Powder Tests, Mr. C. D. Knight.

Trench Mortars, Pyrotechnics and Grenades, Lt. F. C. Shaffer.

Bombs, Mr. Collins.

Antiaircraft Artillery, Lt. Myron Leedy.

Chronographs, Gaging and Impression Work, Mr. Millar and Mr. Jewell.

Field Service Activities, Capt. P. K. Kelly.

Tanks, Tractors and Motor Carriage Artillery, Capt. D. C. Kelly.

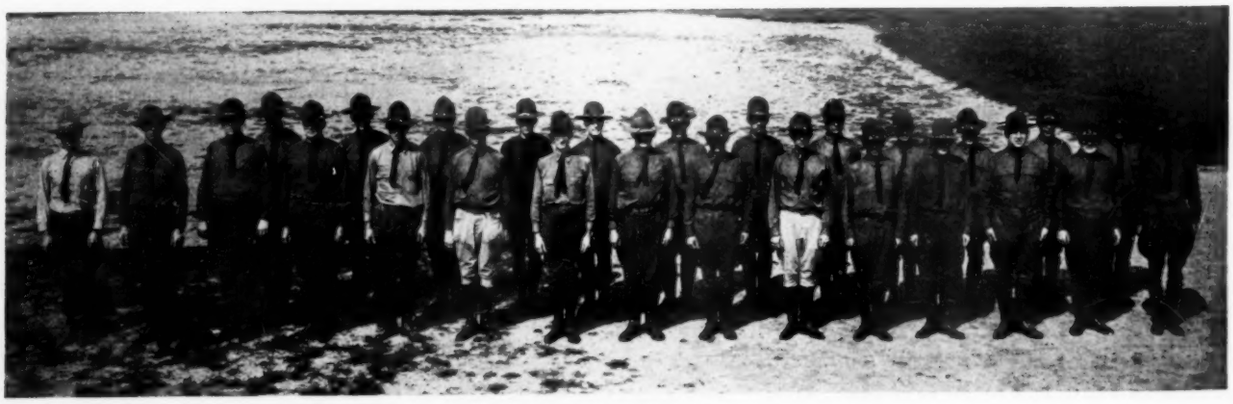
Ordnance Reserve Officers Attend Annual Training Camp

AT

Aberdeen Proving Ground

The First Platoon

The Second Platoon



The Third Platoon

Seacoast Artillery, Capt. H. L. Campbell.
Railway Artillery, Maj. R. H. Hannum.

The Reserve Officers of the Branch Assignment Group who attended the Camp were:

Col. John O. Johnson
Lt. Col. James F. Monaghan
Lt. Col. Frederick E. Wright
Maj. Edward M. Ayer
Maj. Louis E. Brittson
Maj. Marcus G. Gallimore
Maj. Robert W. Gardner
Maj. Walter W. Golden
Maj. Charles O. Gunther
Maj. Isaac S. Hall
Maj. Wm. H. Keen
Maj. Claire G. Landes
Maj. Johnson Morgan
Maj. Ernest V. Reed
Maj. Byron Rife
Maj. Garnet M. Sixsmith
Maj. William C. Swift
Maj. George A. Voss
Capt. Ephraim J. Almquist
Capt. Jay S. Buckley
Capt. Robert B. Cable
Capt. Leo A. Codd
Capt. Manly A. Collins
Capt. J. Leroy Delany
Capt. Russell H. Drunkenbrod
Capt. Paul J. Guinther
Capt. Warren B. Hood
Capt. Wilbur M. Jefferys
Capt. Harry I. Lewis
Capt. Emanuel J. Livingston
Capt. Floyd E. Mehrhof
Capt. Edward R. Neville
Capt. Joseph H. Nichols
Capt. Ralph S. Nichols
Capt. Ellis R. Northrop
Capt. James B. Ramage
Capt. Harry E. Rogers
Capt. Wilbur W. Runyan
Capt. Chas. A. Tibbals, Jr.
Capt. James C. Vickery
Capt. Herbert E. West
Capt. Silas Williams
Capt. Claude W. Wright
Capt. Frank A. Young
1st Lieut. Walcott D. Bartlett
1st Lieut. John O. Brennan
1st Lieut. Floyd N. Calhoon
1st Lieut. John S. Carter
1st Lieut. James W. Cottrell
1st Lieut. John F. Drennan
1st Lieut. Alden Q. Ellis
1st Lieut. Abraham M. Ehrlich
1st Lieut. Donald C. Fabel
1st Lieut. Dana E. Hill
1st Lieut. Morris P. Keith
1st Lieut. Frederick J. Lanz
1st Lieut. Herbert H. Mitchell
1st Lieut. Kenneth C. Monroe
1st Lieut. Walter H. Montgomery
1st Lieut. Harry H. Needham
1st Lieut. E. Richard Page
1st Lieut. Robert E. Pate
1st Lieut. Harold J. Preble
1st Lieut. Carlyle E. Strand
1st Lieut. Gordon C. Tibbitts
1st Lieut. John P. Vollrath
1st Lieut. Price W. Williams
1st Lieut. Albert M. Young
2nd Lieut. Donald D. Alexander
2nd Lieut. Edward B. Allen
2nd Lieut. Raymond G. Curtin
2nd Lieut. Richard R. Garrison
2nd Lieut. Wm. S. Gould, Jr.
2nd Lieut. Armine L. Gracey
2nd Lieut. Arthur B. Hansen
2nd Lieut. Thomas L. Hapgood
2nd Lieut. Ernest R. Hedstrom
2nd Lieut. Amos W. Huyett
2nd Lieut. Charles S. Janes
2nd Lieut. Kelsey H. Jewett
2nd Lieut. James W. Longueil
2nd Lieut. Charles H. McCann
2nd Lieut. Wm. G. Mollenberg
2nd Lieut. Frederick J. Mollerus
2nd Lieut. Nelson H. Mosher
2nd Lieut. Chester Mueller
2nd Lieut. Gerald L. Parker
2nd Lieut. Ralph C. Parmenter
2nd Lieut. Delbert J. Quamen
2nd Lieut. Stone Meyer
2nd Lieut. Buel F. Titus
2nd Lieut. Walter E. Wickstrom

In addition to the Branch Assignment Group officers, the following Territorial Assignment Group officers were at the camp:

Major Walter D. Koch
Capt. Abraham B. Cox
Capt. Leonard A. Haskett
1st Lieut. Robert L. Hoadley
1st Lieut. Mendel Tabaknak

On Friday evening, August 7th, a dance was given by the officers of the Post in compliment to the Reserve Officers attending the Camp, who in turn reciprocated with a dance on the following Friday evening in honor of the officers and ladies at the Proving Ground. Both functions were well attended.

In closing it should be said that all officers who attended the Camp were most grateful for the courtesies shown them. No group of instructors could have given more personal attention or shown greater interest in the classes and all seemed most anxious to do everything possible to make the Camp both enjoyable and instructive.

The moral to this narrative is: Every Ordnance Reserve officer should attend a training camp—it is a great experience—of value to the country and the individual alike.

The National Machine Tool Builders' Association

By

AUGUST H. TUECHTER

THE Machine Tool Builders' Association grew out of a little meeting in New York in 1902 of seventeen lathe builders, called together at the invitation of Mr. William Lodge, President of the Lodge & Shipley Machine Tool Co., of Cincinnati, to talk over their mutual problems in a friendly way. There was reason a-plenty for earnest consideration of the situation that confronted these seventeen builders, and in fact, the whole machine tool industry, at that time.

Competition of twenty years ago was a bitter rivalry. Business judgments were founded on hearsay and rumor,—mostly a jumble of misinformation. The shrewd buyer who was willing to employ such methods found it served his purpose to sow seeds of distrust and enmity among competing sellers. Definite standards of business practice among the members of any given industry were rare. In the face of "business-at-any-cost" policies of the majority, it was a difficult matter for the smaller, weaker companies to formulate sound policies, or to adhere to good business practice. For the machine tool industry, whose problems were so different, so little understood, and so much more difficult than those of industries not so far removed from the consumer, it was hard even to determine what was good policy and what was not.

Mr. O. B. Iles
President, National Machine Tool Builders' Association.

Mr. Lodge had given these matters especial thought. Early in the history of his own business, he had discerned greater opportunities in specialized production, and by 1900 had become one of the leaders in the manufacture of lathes. Here again the peculiar problems of the machine tool industry became intensified when the field was narrowed down to but one of its products. The rapid expansion of all industrial enterprise through the nineties had been reflected in the growth in the number of machine tool shops. Particularly through the Middle West many new shops had sprung up, all eager to take what business could be had on any terms, regardless of the effect on their own business, or on the industry as a whole. The future looked anything but inviting. A demoralized industry cannot go forward, and demoralization appeared to be lying in wait just around the corner.

Mr. Lodge and others of the Lathe Group were convinced that fear and distrust arising out of ignorance of competitors' policies, were strongly contributing elements in the threatened demoralization; that the substitution of a friendly spirit of coöperation was a necessary first step in combating the unsound practices and evils that were promising to choke off their industry's progress. So a meeting was called. The seventeen manufacturers who responded unanimously, endorsed the Association idea, and out of that meeting grew our present organization.

On the second day a committee appointed for the purpose presented a Constitution and By-Laws for a permanent organization, to be known as the National Machine Tool Builders' Association, with the object—

"To promote the interests of the National Machine Tool Builders in the direction of good fellowship, and the liberal discussion of subjects pertaining to the sale of machine tools."—Constitution and By-Laws, 1902.

Officers were elected as follows:

President—F. L. Flather, Flather & Co., Inc., Nashua, N. H.

Vice President—William Lodge, The Lodge & Shipley Machine Tool Co., Cincinnati.

2nd Vice President—W. P. Davis, W. P. Davis Machine Tool Co., Rochester, N. Y.

Secretary—P. E. Montanus, Springfield Machine Tool Co., Springfield, O.

Treasurer—Enoch Earle, Blaisdell & Co., Worcester, Mass.

Good fellowship was the central thought of the plan—good fellowship and a friendly interchange of ideas. Out of this it was hoped would emerge a universal adoption of those policies or practices found to be good and beneficial to the whole industry.

It might be interesting here to review the names of the firms who were represented at that early meeting—

American Tool Works Co., Cincinnati.
P. Blaisdell & Co., Worcester, Mass.
Bradford Machine Tool Co., Cincinnati.
W. P. Davis Machine Co., Rochester, N. Y.
Draper Machine Tool Co., Worcester, Mass.
Fairbanks Machine Tool Co., Springfield, O.
Flather & Co., Inc., Nashua, N. H.
Greaves-Klusman & Co., Cincinnati.
Hamilton Machine Tool Co., Hamilton, O.
Hendey Machine Co., Torrington, Conn.
R. K. LeBlond M. T. Co., Cincinnati, O.
Lodge & Shipley M. T. Co., Cincinnati.
Prentice Bros. Co., Worcester, Mass.
Rahn, Mayer & Carpenter Co., Cincinnati.
F. E. Reed Co., Worcester, Mass.
Schumacher & Boye, Cincinnati.
Springfield Mch. Tool Co., Springfield, O.

Some of these companies are no longer in business, and some others have consolidated with other companies, so that they no longer retain the original names; seven of these companies are still on the roster of our membership.

By October, when the first annual meeting of the Association was held at Cleveland, O., the membership had grown to 33 companies, representing lathes, milling machines, drilling machines, shapers, and grinding machines. That first convention had a 100% attendance—every one of the 33 member companies being represented.

Although the main object of the Association was the promotion of good fellowship, it is an interesting fact that immediately following its organization, the attention of all members was directed toward the earnest consideration of some specific problem—sometimes one that affected only the machine tool builders, more often a question of general interest affecting all industries.

It is a coincidence that the first paper presented before the Association at this first annual meeting in 1902 covered a subject that is still a live one to almost all industry today. The paper was presented by Mr. F. A. Halsey of the "American Machinist," subject "Non-adoption of the Metric System by the United States Government." Mr. Halsey's address invited the attention of the machine tool industry to the bill then pending in the U. S. House of Representatives, for the adoption of the metric system in connection with all government work. The paper resulted in a resolution of protest against the enactment of the bill —"because

(1) The experience of Germany in which the old measures are still in large use, has shown that the change cannot be completed even after a generation of confusion.

(2) The sale of many million dollars worth of machine tools has been made abroad, by members of this Association, especially to France and Germany, without requirement or request by the purchasers for changes in general construction to conform to metric measurements, the only changes being in adjusting and measuring screws, the great majority of machines needing no changes whatever.

(3) The adoption of the metric system would entail an enormous first cost of new equipment to conform to the new standards, and a constant increased cost in the maintenance of a double standard for repairs and renewals; and a consequent increased cost of the product to the consumer."—Report of Annual Convention, October, 1902.

Copies of this resolution were ordered sent to the Chairman of the House Committee, the National Metal Trades Association, and the National Association of Manufacturers.

This is the first record that we have of machine tool builders acting as an industry on a question of interest to all the manufacturers in the country. It represents the awakening of an industry conscientiousness—a realization of a new power that from that time on was to make its own place in the nation's business. A review of later discussions shows that at some time or other practically every problem that confronts industry today has come in for its share of thought and attention.

Standardization of parts, that we look upon as a question of our own time, was earnestly advocated by Mr. Lodge, of the Lodge & Shipley Co., in a paper before the Association at their annual meeting of 1903, when the new Association was but a year old. It was about the time of the introduction of high speed steel, when an unprecedented revolution in design was imminent. Commenting on the radical changes that were being foreshadowed, Mr. Lodge advocated the adoption of standard parts that would facilitate "interchangeability of face plates, chucks, and tools." His argument brings us very close to the present day discussion on this same subject. He said—(quoting from a report of his address):

"It would be to the interest of this Association, if it could possibly be brought about, that some standard be adopted. Why may not all manufacturers of machine tools have the same size of general bearings, the same size of nose for the lathe spindles for the different sizes of lathes, so that our customers may find it easy to transfer face plates, chucks, and tools from one machine to another, irrespective of who may have been the manufacturer? If this matter can be brought about we shall be the first country to have adopted a uniformity. This would be a most important matter, not only to ourselves, but to the men to whom we sell."—*Iron and Machinery World*, November, 1903.

In 1906, when the United States Government appropriated a large sum of money for an investigation of possibilities of foreign commerce, the Association secured recognition for the Machine Tool Industry as an important factor in our export trade. European markets for machine tools were then absorbing approximately 30% of our total output, and were giving promise of even greater development. Capt. Godfrey L. Carden, of the United States Revenue Cutter Service, who was appointed by the Department of Commerce and Labor to represent the industry, spent two years in Europe. His reports, published from time to time in the "Daily Consular and Trade Reports" of the Department of Commerce and Labor, were most encouraging, testifying to the superlative merit in design and workmanship of American tools, while pointing out marketing policies to be followed to strengthen our position. These reports were of inestimable value to the individual firms who were striving to build permanent markets in European countries.

In 1907 a study was made of machinist apprenticeship contracts. Sample terms and contracts were drawn up for

the guidance of members, and arrangements made for an engraved diploma bearing the seal of the Association, to be given to the apprentice on the successful completion of his term. The plan outlined is still successfully followed at the present time.

In 1908, when revision of the tariff was a question of national concern, machine tool builders, through the Association, secured a separate classification for the industry under the heading "machine tools," volunteering at the same time a reduction in the tariff on machine tools. The reduction held until after the World War, when the Tariff Committee restored the percentage as a protection against a possible flood of foreign-made tools brought in at depreciated currency prices, and the consequent weakening of an industry indispensable to the national defense.

The part the industry played in speeding up the machine capacity during the World War is too familiar to all to bear repeating here. It is enough to say that once more the Association justified its existence by coöperating with government departments, and keeping members of the industry informed of new developments. The trials of the Ordnance Department in the last war in mobilizing industry are a matter of record, and the part that trade associations played in bringing about coördinated action, has won for them all well deserved commendation.

The demands made upon the Association during the war and post-war periods emphasized the need for a central association office, with a full-time general manager and assistants. In 1920 the Executive Committee recommended that steps be taken to raise the Association to the dignity of a business organization, making of it a bureau of information for the use of the members and all others associated with the industry. The Executive Committee especially recommended that a study be made of the industry's economic position, as a foundation for a campaign of education to put the business of the industry on a sounder, safer basis. These recommendations were enthusiastically endorsed by the members, and Mr. Ernest F. DuBrul, our present General Manager, was chosen to conduct the work. By January, 1921, he had established an office at Cincinnati, had organized a working force, and at a special meeting of the Association called in February, 1921, was able to present a brief survey of the industry's position relative to other basic industries, and to show the trend of the industry's orders, which at that time was sharply downward.

Gloomy though the outlook was just before the depression of the summer of 1921 had reached bottom, Mr. DuBrul's work received the hearty endorsement of the members, and he was authorized to continue his studies. This work, which is being carried forward now as only one part of our Association activities, is resulting in a growing appreciation of the isolated position of the industry in respect to the nature of its problems,—its long periods of depression when business is bad, and its short, sharp peaks of activity, when all other business is prosperous; its difficult marketing problems; its tedious management problems; and its financial hazards.

The support of a central office has made it possible to expand our activities from the twice yearly friendly meetings to serious work in many directions besides economic research. We have a bulletin service to keep members posted on questions relating to administrative, technical and sales questions. We have taken up seriously and are sponsoring certain standardization projects through the American Engineering Standards Committee. We are conducting an advertising campaign to educate the user industries to the value of keeping closer tab on their machine tool equipment. In coöperation with the Chamber of Commerce effort to raise the ethical standards of all industry, we have adopted the "Principles of Business Conduct" drawn up by the Chamber, and are setting out for all to see the practices that are destructive of these principles within our own industry. We are coöperating closely with the U. S. Department of Commerce through the Industrial Machinery Division, to the end that their work and ours may be more effective on behalf of all machinery builders.

Ours is a pardonable pride in the things that our Association has accomplished in the twenty-three years of its existence, and we gratefully attribute our achievements to the quality of the leadership that it has been our good fortune to enlist during this period. Throughout our history, the best and noblest of the industry's executives have given of their time and effort, and have held it an honor to serve on our Board of Directors. The honor of the Presidency of the Association has been accorded to eleven of these executives. We are proud to list their names and the terms of their office; this is our honor roll:

Year	*President*	*Firm*	*City*
1902-03	Joseph Flather[1]	The Flather Company	Nashua, N. H.
1903-05	William Lodge[2]	Lodge & Shipley Machine Tool Company	Cincinnati, O.
1905-07	W. M. Woodward[3]	Woodward & Powell Planer Company	Worcester, Mass.
1907-09	F. L. Eberhardt	Gould & Eberhardt	Newark, N. J.
1909-11	F. A. Geier	Cincinnati Milling Machine Company	Cincinnati, O.
1911-13	E. P. Bullard, Jr.	Bullard Machine Tool Company	Bridgeport, Conn.
1913-15	W. A. Viall	Brown & Sharpe Manufacturing Company	Providence, R. I.
1915-18	J. B. Doan	American Tool Works Company	Cincinnati, O.
1918-20	A. E. Newton	Reed Prentice Company	Worcester, Mass.
1920-22	August H. Tuechter	Cincinnati Bickford Tool Company	Cincinnati, O.
1922-23	Edw. J. Kearney	Kearney & Trecker Corporation	Milwaukee, Wis.
1923-24	Ralph E. Flanders	Jones & Lamson Machine Company	Springfield, Vt.
1924-25	O. B. Iles	International Machine Tool Company	Indianapolis, Ind.

[1]Died 1907. [2]Died 1917. [3]Died 1923.

The 9th Corps Area Staff Training Camp

Ordnance Section

By

LT. COL. FRED L. M. MASURY, ORD. RES.

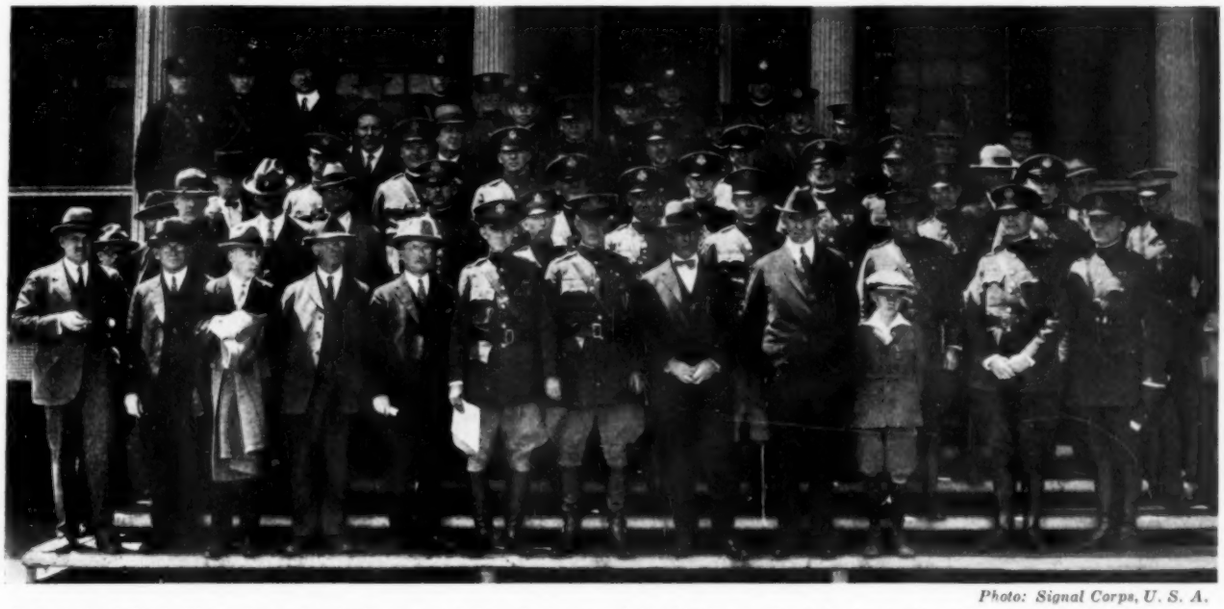


Photo: Signal Corps, U. S. A.

Ordnance Officer Students and Members of Army Ordnance Association at Benicia Arsenal, California, May 20, 1925

IT IS somewhat difficult to write upon the subject of the Instruction Camp for Reserve Officers of the Staff Corps of the Ninth Corps Area without showing what might be considered as excessive enthusiasm; but the way in which subjects were presented by the officers who delivered lectures, the manner in which all details of the camp were arranged, and lastly, the spirit of *comaraderie* in its best sense, that was injected into all the work, fully justifies all praise for those officers of the Regular service who contributed their valuable efforts toward the success of the camp.

The camp was held at the Presidio of San Francisco from May 10th to 24th, inclusive; the first day being for enrollment and an allowance of time required for those Reserve officers who lived at a distance to journey from their homes to the camp, and the last day being for the settlement of pay vouchers, etc., and the return home.

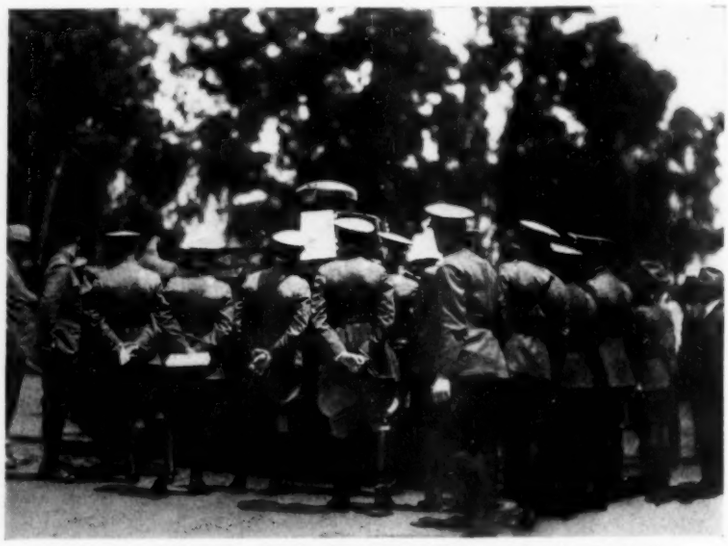
All staff branches of the Reserves were represented at the camp; a total of 104 officers being enrolled, sixteen of whom were of the Ordnance Reserve. The work actually began on the morning of the eleventh and practically all enrolled officers were present and were welcomed by Col. F. J. Morrow, Inf., Camp Commander, who at once, by his genial and sincere manner, made all student officers feel absolutely at home. Followed an address by Major General Helmick, Inspector General of the Army; this was extremely enlightening and instructive; the general, in his delightful way, tried to dispel those fears which most of his listeners had of his department.

A reception was afterwards held in the Officers' Club, where the officer students assembled in branch groups at designated places and met their chiefs of branches of the Regular service—this proved a splendid way for all to become acquainted, and, upon later adjourning to the Palace Hotel for a luncheon given by the Association of the Army of the United States, the "ice" was effectively broken and each student felt entirely at ease when the actual work afterwards began.

There were two sessions each day, except Saturday; at the morning session all branches were assembled together and were addressed by Regular Army staff officers on subjects pertaining to their respective branches, covering its organization, duties and functions—at the afternoon sessions each branch received instruction in its own special line and at this time only such subjects were taken up as applied to the branch itself. The morning sessions were for general instruction, imparted by means of lectures, and the afternoon sessions for special and more intensive training, and this was accomplished by conferences, problems and "talks" by the instructors.

The idea of the morning session was to make the Reserve Staff officer, who is usually a specialist in some particular line, thoroughly conversant and familiar with the general working of all staff branches; by this method he not only arrives at an appreciation of the importance of the operations of branches other than his own but is better fitted to co-operate with them for the benefit of his own branch and the service in general. The specialist is too apt to see only the "hole" in his own particular doughnut—the course of instruction, as arranged, materially broadens this viewpoint.

On May 14th, much to the regret of all, the Camp Commander, Col. Morrow, was compelled to leave for Alaska on an inspection trip — the organization, however, functioned perfectly under his able assistants, Lt. Col. Coughlan and Maj. C. A. W. Dawson, both of whom were untiring in their efforts to make the camp the complete success that it proved to be—the student officers found all things worked out for their comfort and convenience—such minor details as those covering that old *"bete noir,"* the pay voucher, were so ironed out that making out the voucher was a real pleasure instead of a night-mare!



Ordnance Officer Students Examining Tank, Benicia Arsenal, California, May 20, 1925

THE PROGRAM OF MORNING SESSIONS

May 11th

Address by Camp Commander,
Col. F. J. Morrow, Inf.
Address by Inspector General of the Army,
Maj. Gen. Eli A. Helmick.
Address by Chief of Staff of Ninth Corps Area,
Col. A. V. P. Anderson, G. S. C.
Review of the 30th Infantry and Visit to Barracks.

May 12th

Lecture, "Organization and Functioning of War Department,"
Col. F. J. Morrow, Inf.
Lecture, "Mobilization in General—Duties and Functions of G-3,"
Maj. T. A. Terry, C. A. C.
Lecture, "Care of Troops,"
Col. E. L. Munson, M. C.

May 13th

Lecture, "Supply With Respect to Mobilization,"
Col. H. F. Rethers, Q. M. C.
Lecture, "Signal Corps and Signal Communication,"
Maj. A. E. Larrabee, S. C.
Lecture, "Procurement of Personnel in Mobilization—Duties and Functions of G-1,"
Maj. R. Blaine, G. S.

May 14th

Lecture, "Industrial Mobilization,"
Maj. M. L. Brett, O. D.
Lecture, "The Organized Reserves,"
Col. F. L. Munson, Inf.
Lecture, "Military Intelligence — Duties and Functions of G-2,"
Lt. Col. W. R. Standiford, G. S. C.

May 15th

Lecture, "Duties and Functions of Inspector General's Dept.,"
Col. W. C. Short, I. G. D.
Lecture, "The National Guard,"
Col. E. A. Sirmyer, F. A.
Lecture, "Infantry, Organization and Functions,"
Col. C. S. Lincoln, Inf.

May 16th

Lecture, "Duties of the Medical Officer in Mobilization."
Major Parker, M. C.
Lecture, "Organization of Air Service and Present Day Activities,"
Lt. Col. F. P. Lahm, A. S.
Lecture, "San Francisco Ordnance District,"
Maj. M. L. Brett, O. D.

May 18th

Lecture, "Cavalry—Tactical Functions,"
Col. W. C. Short, I. G. D.
Lecture, "Functions and Operations of the Ordnance Department,"
Lt. Col. E. M. Shinkle, O. D.
Lecture, "Coast Artillery Corps—Its Relation to Other Branches,"
Brig. Gen. H. D. Todd.

May 19th

Lecture, "Duties of the Engineer Corps,"
Col. T. H. Jackson, C. E.
Lecture, "Duties and Functions of Judge Advocate General's Department,"
Col. G. N. Kimball, J. A. G.
Lecture, "Finance — Auditing — Property Accountability."
Capt. H. G. Foster, F. D.

May 20th

Lecture, "Reserve Officers' Training Corps,"
Maj. H. L. Jordan, Inf.

Lecture, "Citizens' Military Training Camps,"
Col. R. B. Lister, Inf.
Lecture, "Staff Coördination — Duties and Functions of General Staff in Battle,"
Col. L. R. Holbrook, F. A.

May 21st

Lecture, "Positive System of Coast Defense,"
Col. J. K. Partello, G. S. C.
Lecture, "Chemical Warfare Service,"
Maj. O. A. Eastwold, C. W. S.
Lecture, "The Quartermaster Corps — Duties and Functions,"
Lt. Col. J. S. Chambers, Q. M. C.

May 22d

Lecture, "Domestic Disturbances,"
Col. A. V. P. Anderson, G. S. C.
Lecture, "Duties and Functions of Adjutant General's Department,"
Col. S. G. Jones, A. G. D.
Lecture, "Morale—Psychology,"
Col. E. L. Munson, M. C.

Program of Afternoon Sessions—Ordnance

May 11th

Conference with Maj. M. L. Brett, O. D., Executive Assistant, San Francisco Ordnance District.
Lecture, "Recent Ordnance Developments" (Lt. Col. Shinkle).
Lecture, "Ordnance Reserve in Ninth Corps Area" (Major Brett).

May 12th

Instruction, "Corps and Division Ordnance Duties" (Lt. Col. Shinkle).
Instruction, "Organization of San Francisco Ordnance District" (Major Brett).

May 13th

Instruction, "Corps and Division Ordnance Duties" (Lt. Col. Shinkle).
Instruction, "Organization of San Francisco Ordnance District" (Major Brett).

May 14th

Topic Discussion.
Address, "Industrial Situation on Pacific Coast,"
Major F. T. Litchfield, San Francisco Chamber of Commerce.
District War Game—Organization of San Francisco Ordnance District.

May 15th

Address, "Steel Industry on Pacific Coast,"
Dr. W. J. Crook, Stanford University.
District War Game—Organization and Operation of Administration Division, San Francisco Ordnance District.

May 18th

Topic Discussion.
District War Game—Organization and Operation of Artillery Division, San Francisco Ordnance District.

May 19th

Topic Discussion.
District War Game—Organization and Operation of Ammunition Division, San Francisco Ordnance District.

May 20th

Visit to Benicia Arsenal.

May 21st

Topic Discussion.
District War Game—Organization and Operation of Small Arms Division, San Francisco Ordnance District.

May 22d

Topic Discussion.
District War Game—Contracts; factory war plans, machine tool requirements, etc.

Topics taken up for discussion, in class, at the afternoon sessions, covered very thoroughly such subjects as Industrial Mobilization, Ordnance Mobilization (Ordnance Orders No. 569 and No. 573), Administration, Finance, Personnel and Training.

The District War Game was "played" by the several District Office Divisions with quasi contractors actually present, or represented by their engineers or experts, and the ways and means of handling all details of proposed allocated contracts were discussed; the contracts, with their accompanying blue prints and specifications, being at hand for reference.

Another interesting and instructive game was played by a group of several Ordnance officers who were assigned the task of making up a "Corps Area Ordnance Office Annex," to be submitted to Corps Area G-4, which dealt with the supply of ordnance matériel to certain troops designated, in the game, by the mobilization orders.

Unfortunately, lack of time precluded the Ordnance officers from taking part in the war game of the "Western Frontier Command."

It will be seen from the above programs how completely the whole subject of staff organization, administration and functions was covered and how much attention was given to the instruction of the Ordnance students in their special duties.

Visit to Benicia Arsenal

One whole day was spent by the Ordnance section at Benicia Arsenal, where a very complete program had been arranged by Major Smith, the Commandant, in connection with the spring meeting of the Army Ordnance Association, California Post. The good ship EL AQUARIO, of the Quartermaster Department, conveyed the group from the wharf at San Francisco to the Arsenal and return—a very pleasant trip. Upon arrival at Benicia the class was at once started upon an instructive tour of the shops and storage warehouses. At the shops for the repair of small arms, optical instruments and mobile artillery, full explanation was made of the details of the work being carried on; many parts of both large and small arms had been completely disassembled, such as breech mechanisms and recuperators, for the benefit of the students; a baby tank was taken out for an airing and put through its paces.

The student officers and members of the Army Ordnance Association were guests of the Board of Supervisors of Solano County at luncheon, served in the barracks. Colonel Charles N. Black, vice-president of the California Post, presided at the meeting following the luncheon, which was addressed by Major Smith, Commanding Officer of the Arsenal, and Mr. Jackling, the well known builder of the large Government powder plants during the World War.

After luncheon and some photographic operations on

the group by a member of the Signal Corps the tour of inspection was continued to the magazine area and wound up with a demonstration at the target range of the Browning machine rifle and gun with mixed service and tracer ammunition, the 37-mm. gun, the 3-inch Stokes trench mortar, the Very pistol and several other small pieces of ordnance.

The Coast Defenses

One entire afternoon was devoted by the Ordnance Section to inspecting some of the harbor defenses, which included a mortar battery with its fire control system and a mining casemate with its control. The section also witnessed the firing of a battery of 155-mm. guns from a temporary emplacement on the ocean front.

Subsistence, Housing and Amusement

Many of the student officers lived in special barracks at the Presidio, while others stopped at hotels in San Francisco or in their own homes.

Meals furnished at the Presidio were very efficiently cooked and served by the personnel of the Cooks and Bakers School—the only criticism offered being that it was too good and there was too much of it.

A delightful hop, given at the Presidio in honor of the Reserve officers, was well attended and all the officers truly appreciated the courtesy extended; the ladies of the Post thoughtfully saw to it that there were no Reserve "wall flowers."

One can place under this heading the flight in aeroplanes indulged in by many of the student officers thru the courtesy of the Air Service at Crissy Field—needless to say, there were no mishaps.

The Ordnance students attended a luncheon tendered by the Ordnance District Chief, Col. Bruce Cornwall, at which, unfortunately, the genial host could not be present, as he was in the East at the time; Major Brett, his Executive Assistant, did the honors in his place.

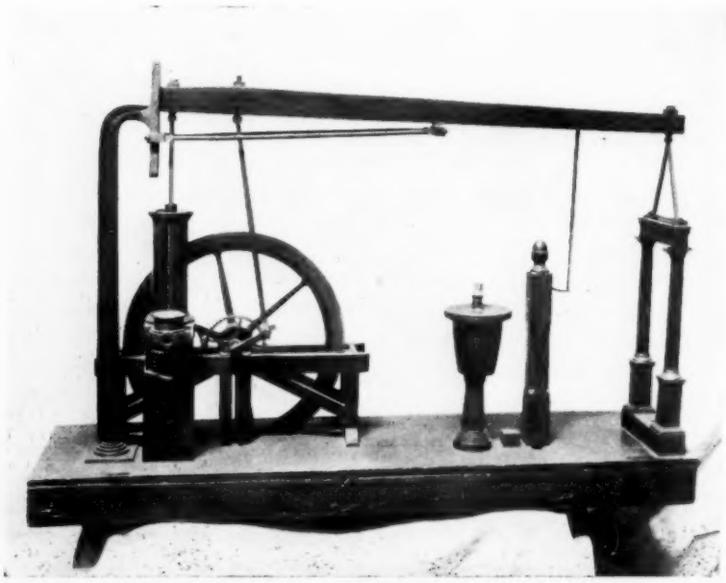
Ordnance Student Officers

Lt. Col. Fred L. M. Masury, Santa Barbara, Cal.,
Maj. W. H. Adams, Burbank, Cal.,
Maj. E. J. Ellis, Los Angeles, Cal.,
Maj. James Spiers, San Francisco, Cal.,
Maj. C. F. Wieland, Berkeley, Cal.,
Capt. D. H. Atherton, Oakland, Cal.,
Capt. A. B. Domonoske, Berkeley, Cal.,
Capt. F. L. Hutsler, Beverly Hills, Cal.,
Capt. Wm. M. Moody, Berkeley, Cal.,
1st Lt. G. E. Frahm, San Francisco, Cal.,
1st Lt. G. W. Ridgeway, Reno, Nevada,
1st Lt. A. J. Stevens, Oakland, Cal.,
1st Lt. Howard Witten, Stockton, Cal.,
2d Lt. L. A. Anderson, San Francisco, Cal.,
2d Lt. J. C. Cooper, Los Angeles, Cal.,
2d Lt. S. K. Rindge, Los Angeles, Cal.

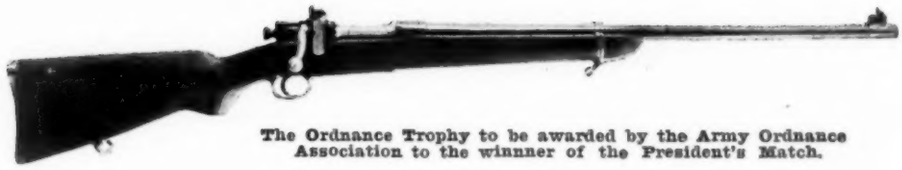
An Appreciation

One would not have believed that such an excellent course of ordnance instruction could have been arranged so many hundreds of miles away from the Manufacturing Arsenals and Proving Grounds; the Ordnance officer students appreciate greatly the value of the instruction received at this Staff Camp and have felt fortunate indeed in having had, as their branch instructors, such efficient Ordnance officers as Lt. Col. Shinkle and Major Brett, who, throughout, were ever solicitous for their training and instruction.

One of the Interesting Mechanical Exhibits of the Franklin Institute



Model of Oliver Evans' Columbian High-Pressure Steam Engine, Made by Rush and Muhlenberg.



The Ordnance Trophy to be awarded by the Army Ordnance Association to the winnner of the President's Match.

The Ordnance Trophy

By

MAJ. GLENN P. WILHELM, ORD. DEPT., U. S. A.

THE Army Ordnance Association announces that it will award an Ordnance Trophy annually to the winner of the President's Match of the National Rifle Matches, the trophy to consist of a rifle representative of the highest development of the art of rifle manufacture at Springfield Armory. Each year a new rifle embodying the latest in improvements will be awarded, the trophy in each case to become the individual property of the winner.

The Ordnance Trophy should be a worthy addition to the fine collection of trophies now available for award in the competitions conducted in connection with the National Matches. It is particularly appropriate for the President's Match which is an individual competition fired with the service rifle at ranges of 200, 600 and 1,000 yards.

For the winner of the 1925 President's Match it has been decided to award a "Springfield Special," a sporting type caliber .30 rifle especially selected for accuracy and beauty. The trophy is typical of the style NRA as produced at Springfield Armory, differing from the standard article only in that the stock is checked and an engraved gold plate is let into the right side of the butt. This plate will be engraved with the name of the winner.

The components entering into the assembly of the rifle have been specially selected and are of the best quality. Special care has been exercised in assembly and every effort made to produce as accurate a rifle as possible.

The barrel is specially selected to National Match specifications, ground to the sporting type contour. It is fitted with a service front sight. The rear sight is a Lyman 48 mounted on the bridge of the receiver. The bolt is bright and the working surfaces polished. All metal parts are finished either by the Browning or Blueing process, the assembly giving a pleasing appearance. The stock has been selected for its curly grain and hand checked and polished.

The barrel is held to the stock at the lower band. A firm bedding is obtained at this point and a study of targets made with NRA style rifles indicates that this tight bedding insures greater accuracy.

The dimensions and characteristics of the stock are the same as style NRA stocks heretofore manufactured and which have been very satisfactory to the large majority of shooters.

In order to realize more fully the significance of the Ordnance Trophy, it may be desirable to describe some of the most important matches of the National Matches.

There are a great many trophies awarded at Camp Perry, the most famous of which, of course, are the ones for the National Rifle Team Match, as it is this match which gives the National Matches its name.

In the National Rifle Team Match, three magnificent trophies are awarded. For the purpose of these awards, the teams competing are grouped under the head of Service Teams, including the Army, the Navy and the Marine Corps—National Guard Teams and teams representing civilian marksmen.

Drawing of the engraved gold plate on the Ordnance Trophy.

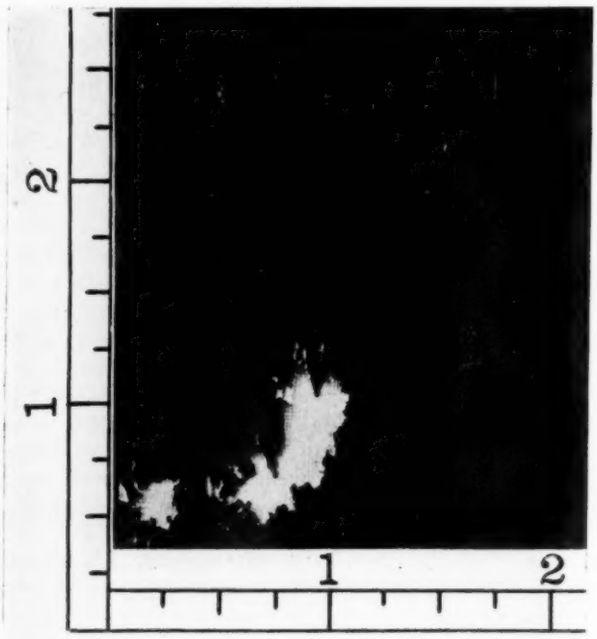
To the winning team is awarded the National Trophy as provided in the law which, enacted in 1902, created the National Matches.

The team with second high score in either of the classes remaining after the National Trophy is awarded, wins the Hilton Trophy. This Trophy was presented in 1878 by the Honorable Henry Hilton, of New York, to the National Rifle Association as a championship match trophy, originally open to teams from the Army, Navy, Marine Corps, National Guard of the United States and the regular Army, Militia and Volunteers of foreign countries.

To the high team in the third class after the awards of the National and Hilton trophies, goes the Soldier of Marathon. This is the oldest team trophy in existence, having been presented to the National Rifle Association in 1875 by the Commander-in-Chief on behalf of the State of New York. It was formerly first prize in the Interstate Military Match.

In 1902, when Congress instituted the National Matches, the Hilton Trophy and Soldier of Marathon were presented to the United States Government by the National Rifle Association, as prizes in the National Team Match.

Among the best known of the Special Matches, other than the National Rifle Team Match, are the President's Match, the Infantry Match, the Navy Match, the Marine Corps Match, the Wimbledon Cup Match, the Herrick Trophy Match, the A. E. F. Roumanian Trophy Match, the Palma Matches, the Leech Cup Match, the Chemical Warfare Service Match, and a number of other Special Matches.



Target of five shots at 200 meters fired by the Ordnance Trophy (Springfield Rifle No. 1266818) using 1925 National Match Ammunition.

An Ordnance Trophy would seem to be particularly appropriate for, with the exception of the combat arms themselves, certainly the next most important service represented at the National Matches is the Ordnance Department. The supply branch which provides the rifleman with his rifle and ammunition should also provide a trophy emblematic of the rifle, and what more significant trophy to the rifleman could be awarded than the rifle itself.

The reasons for selecting the President's Match as a suitable match in which the Ordnance Trophy would be awarded are as follows:

It is considered undesirable to add any more special matches to an already full program.

The President's Match is considered to be one which already possesses the prestige which goes only with the President's name.

This Match is truly representative of the American rifle, as it includes short range, mid range and long range stages.

One of the elements which it is hoped will make the Ordnance Trophy of special interest and value to riflemen is the fact that, with the exception of badges and medals, all the trophies awarded at Camp Perry have merely made the winners of the match the custodian of the trophies, as the trophies do not become the property of the winners. In the case of the Ordnance Trophy, the winner of the match becomes the owner of the trophy, which is his property to do with as he pleases.

The President's Match already has a great many trophies, although the winner of the match, up until this year, has only been awarded an autographed letter from the President of the United States, and a gold medal. It is, therefore, desirable to award the winner another trophy in addition to the above awards, inasmuch as there are trophies awarded to the member of each of the Service Teams who makes the highest score in this Match; i. e., to the United States Cavalryman making the highest score is awarded the Cavalry Cup, which, however, is not presented by the Cavalry but is presented by the 1910 United States Marine Corps Rifle Team. Likewise, the high Marine in the Match receives a trophy presented not by the Marine Corps but by the Cavalry of the United States Army.

In selecting the Ordnance Trophy the rifle was chosen because to a rifleman there is no greater individual prize, and because the history of the rifle will be preserved for future generations by the rifle awarded to the future winners of the President's Match.

It is hoped to have the President of the United States, in person, make the award of the Ordnance Trophy to the winner of this celebrated Match.

The conditions under which the President's Match is fired are as follows:

The President's Match

SQUADDED INDIVIDUAL COMPETITION

Open to: Any citizen of the United States.

Course: 10 shots at 200 yards. 10 shots at 600 yards. 20 shots at 1,000 yards. No sighting shots.

Arm: The service rifle.

Sights: Service.

Ammunition: Any.

Position: 200 yards, standing. 600 yards, prone. 1,000 yards, prone.

Target: 200-yard stage "A." 600-yard stage "B." 1,000-yard stage "C." V's* are scored at 600-yard and 1,000-yard ranges.

*A "V" is a shot in the bull's-eye in an inner circle. It is recorded as a "V" instead of a five. It is used to determine the winner where more than one competitor has the same number of bull's-eyes, the one having the most "V's" being the winner. This method of scoring was necessary, as so many competitors were able to shoot all their shots in the bull's-eye. It was impracticable to reduce the size of the bull's-eye because of the difficulty in sighting at the longer ranges at a smaller area.

Relation Between Pressure, Volume and Temperature of Gaseous Air Under High Compression

With Plots and Illustrations of Their Use

By

COL. EDWARD F. MILLER, ORD. RES.

IT IS seldom that an engineer deals with gases under high compression; the greater part of his work with gases is at pressures under 300 lbs. where it may be assumed with sufficient accuracy for most engineering work that the gas is a "perfect gas" or one which follows the law that for isothermal compression the pressure times the volume is a constant.

It is known that no gas follows the law of perfect gases, the variation from the law getting more and more evident as the pressure increases, until at 3000 atmospheres the product of P and V for an isothermal compression is, for some gases, three to four times the product of P and V at atmospheric pressure.

The experiments of Amagat on the compressibility of gases at high pressure have given data which show the variation in the product of P and V at different pressures. In place of the equation $PV = RT$ which applies to the "perfect gas," a number of equations have been proposed which it was felt would give results more in accord with the real facts. The one probably best known is that of Van der Waals $(P + \frac{a}{V^2})(V - b) = RT$. The term $\frac{a}{V^2}$ allows for the internal pressure tending to compress the gas due to the attraction between the molecules and the term $(V - b)$ gives the free volume or that left after deducting the volume of the molecules themselves. An equation developed by Dr. F. G. Keyes of the Massachusetts Institute of Technology gives values very closely in accord with the results of experiment. This equation has been used in laying down the constant volume lines which appear on the plots.

From an examination of the equation it is evident that a constant volume line plotted against temperature and pressure would be a straight line. These lines do not meet at a point at low pressure and low temperature, but become tangent to a curve.

The values as calculated from the equation and converted into English units are given in the accompanying table. With the aid of these figures one may easily make, at large scale, plots similar to the small ones which appear with this article.

Should a plot be made at large scale the slope of any constant volume line intermediate between those plotted may be found by drawing in two additional curves located as follows: As abscissae lay off at large scale volumes .05, .06, .07, etc., up to .25. The ordinates for these volumes will be the vertical heights at which the sloping constant volume lines plotted against temperature and pressure intersect the two temperature lines chosen.

For example, suppose the two temperatures are 600° and 400°. The ordinates for volume .05 are the heights at which the sloping constant volume line .05 cuts the 600° and the 400° temperature line. In the same way ordinates for any volumes for which the sloping constant volume lines have been drawn may be obtained and a series of points defined. Curves through these two sets of points may now be used to find the intercept on the 400° and on the 600° temperature line for any given volume and the sloping constant volume line for the given volume may then be drawn as a straight line extending through these points.

By differentiating Keyes equation so as to get values of $(\frac{dP}{dt})_V$ and $(\frac{dV}{dt})_P$ and substituting these in the general heat equation, $C_p - C_v = AT(\frac{dV}{dt})_P (\frac{dP}{dt})_V$ where A is the heat equivalent of a unit of work. Values of $\frac{C_p}{C_v}$ have been calculated for a number of temperatures and plotted against pressure as abscissae.

THE value of P for any volume for an isothermal compression or for an expansion for one pound weight may be read directly from the plot giving the relation between PV and T by following along one of the vertical lines representing temperature.

Similarly the increase in temperature for a constant pressure expansion between two volumes may be read by following along a horizontal line. As an illustration, suppose one pound of air at 70.36° F. to be compressed at constant temperature till the volume decreases from .6 cu. ft. $= V_1$ to .05 cu. ft. $= V_2$. What is the final pressure and what was the work required for the compression? $459.64 + 70.36 = 530 =$ Temp. absolute. The pressure at the start (P_1) is 335 lbs. abs. per sq. inch; at the end (P_2) is 4360 lbs. per sq. inch.

The compression may be represented very closely by a

line having the equation, $P_1V_1^n = P_2V_2^n$. (n) may be calculated, knowing the P and V at each end of the line, by

$$\log P_1 + n \log V_1 = \log P_2 + n \log V_2$$

$$n = \frac{\log P_2 - \log P_1}{\log V_1 - \log V_2} = 1.0327 \text{ for the case chosen.}$$

The work of compression which is equal to the area under the compression curve when pressures are expressed as absolute pressures on the sq. ft. is,

$$\frac{144\ P_2V_2}{n-1} - \frac{144\ P_1V_1}{n-1} = 74{,}860 \text{ ft. lbs.}$$

The work of compression of a "perfect gas" between these volumes would be 335 X 144 X .6 X 2.3026 $\log_{10} \frac{0.6}{.05}$ = 71,920 ft. lbs.

For a *perfect gas* the compression curve for an adiabatic is,

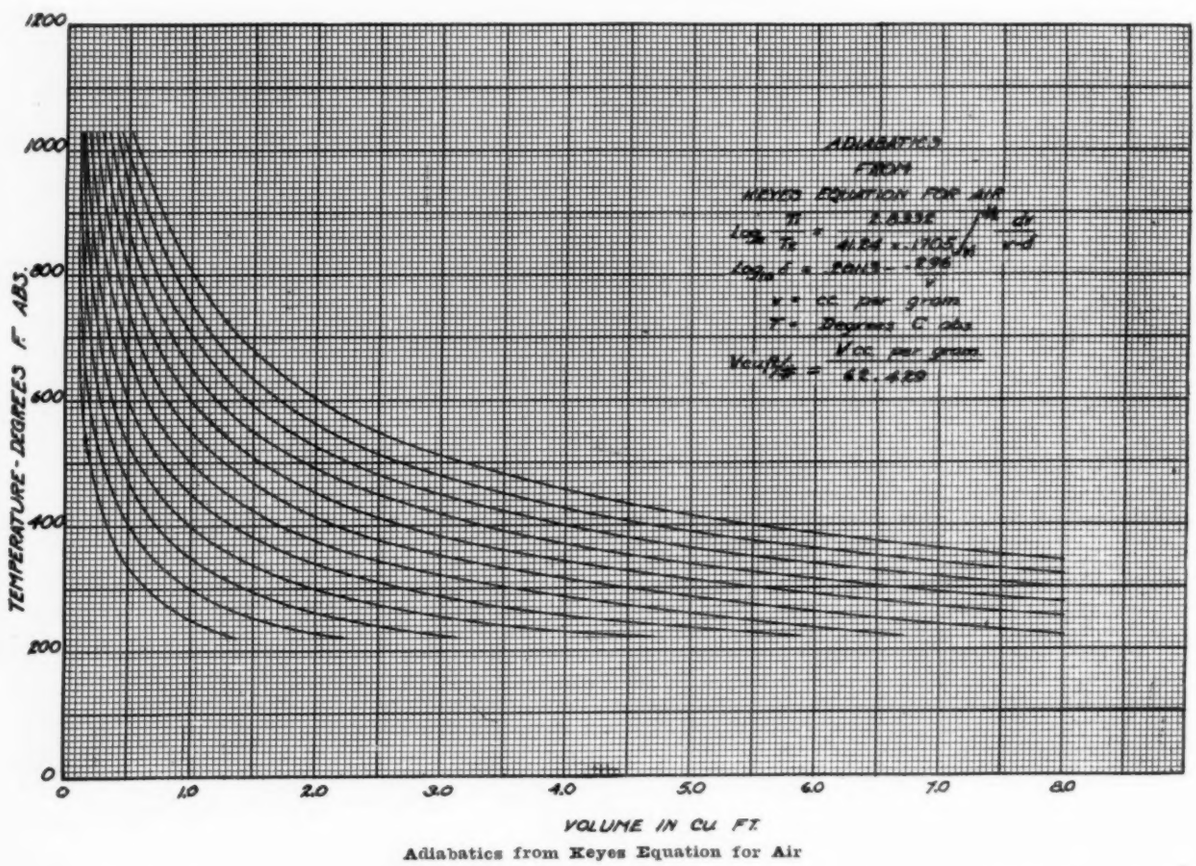
$$P_2V_2 = P_1V_1, \quad \frac{C_p}{C_v} \text{ being constant.}$$

At low pressures air, nitrogen, oxygen, etc., vary but little from a perfect gas, but at high pressures the variation is quite marked.

As the ratio of the specific heats of air at high pressures varies with temperature as well as with pressure it is evident that the pressure volume equation for an adiabatic as given above can be used with accuracy only for low pressures. By means of the general heat relation:

$$dQ = C_v\ dt + (C_p - C_v)\ \left(\frac{dt}{dV}\right)_P$$

with dQ made equal to zero for an adiabatic and with a value of $\left(\frac{dt}{dV}\right)_P$ obtained by differentiating the original



Adiabatics from Keyes Equation for Air

During an isothermal compression heat has to be abstracted. For a perfect gas the amount is equal to the ft. lbs. of work of compression divided by 778, the mechanical equivalent of heat.

For a sudden compression, such as that in an air recuperator, there is no time for any appreciable amount of the heat coming from the work done on the air to be transmitted to the metal and the compression is practically adiabatic.

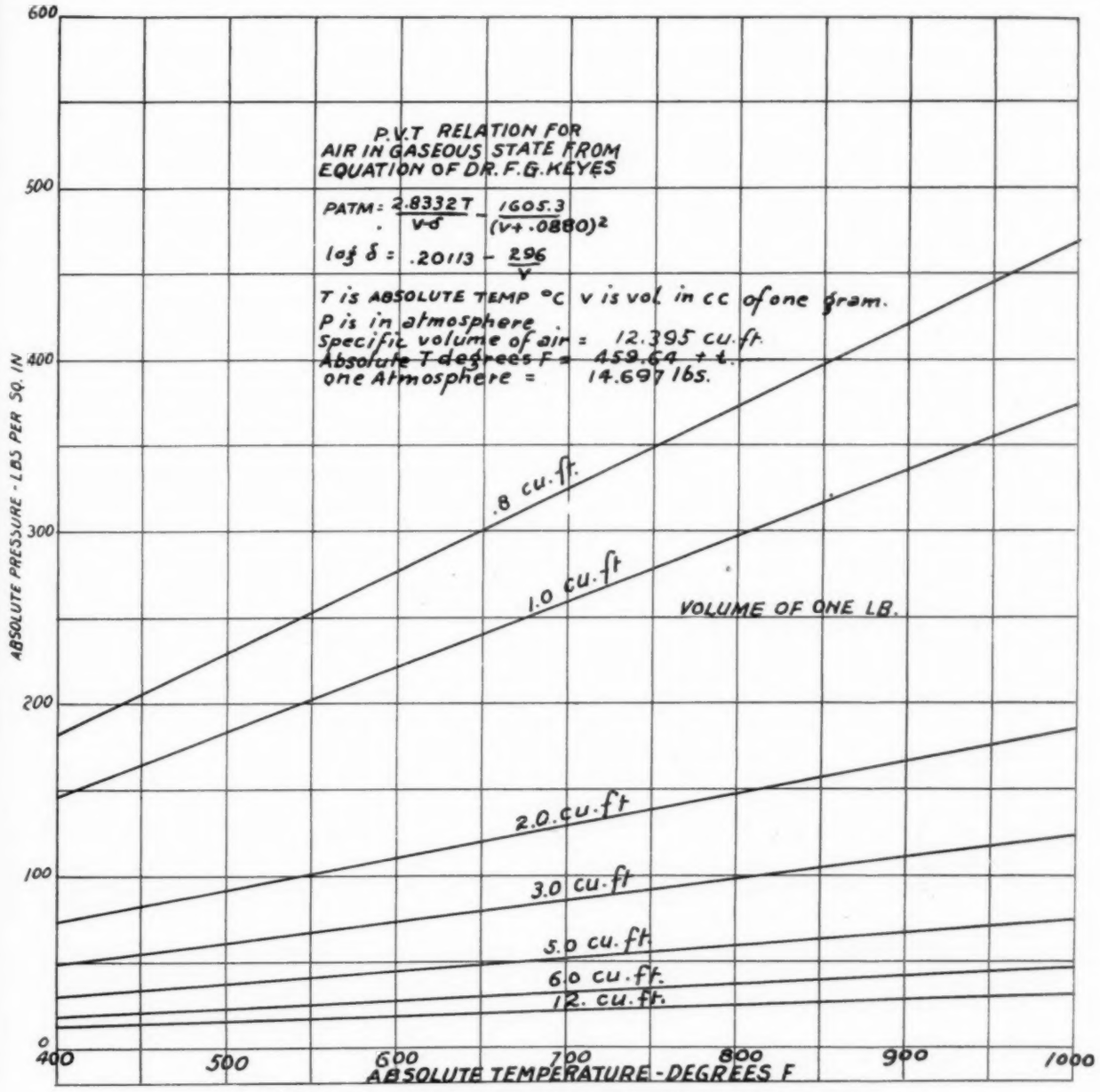
During the first part of the compression there is less difference in temperature between the air and the metal than at the last part and it is probable that the last part of the compression curve falls below an adiabatic, while the first part departs but little from such a line.

equation given by Dr. Keyes the relation given below was obtained:

$$0 = \log_e \frac{T_2}{T_1} + \frac{A\ R}{C_v} \int_{V_1}^{V_2} \frac{dv}{v - d}$$

Values of $\frac{1}{v-d}$ were plotted at large scale and the value of the integral determined between limits, by means of a planimeter.

A series of adiabatics for one pound weight with different initial temperatures were then plotted against volume and temperature. Eight of these adiabatics have been plotted over the volume lines on the P V T plot. The curves although distorted due to the sloping volume lines give accurate values of pressure and temperature at any volume.



P V T Relation for Air in Gaseous State from Equation of Dr. F. G. Keyes

To get the work under an adiabatic compression it has been assumed that for short distances the curve could be closely approximated by an equation $P_1v_1^n = P_2v_2^n$. The values of (n) as calculated for short steps appear on each line.

The proper value of (n) to use for any adiabatic falling between those shown may be obtained by interpolation, measuring distance along constant volume lines.

Illustration

The air recuperator on a 16-inch howitzer has a volume of 13,766 cu. in. when the piston is out and 9,766 cu. in. when the 11½″ diameter piston has moved 38.5 inches.

The cylinder is initially charged with air at 2000 lbs. abs. per sq. inch. Assume temperature as 72°. What will be the pressure at the end of compression and how much work will be absorbed by the compression?

The original volume $\frac{13766}{1728} = 7.9664$ cu. ft. The final volume $= \frac{9766}{1728} = 5.6516$ cu. ft.

Referring to chart, it is seen that 1 lb. of air at 2000 lbs. absolute per sq. in. and at a temperature of 459.64 + 72 = 531.64 occupies a volume of about .098 cu. ft.

$\frac{7.9664}{.098} = 81.26$ lbs. the weight of air in the recuperator.

$\frac{5.6516}{81.26} = .0695$, the volume of 1 lb. at the end of compression. Following along a line parallel with the two adiabatics from the volume .098 and pressure 2000 lbs. to

volume .0695 a rough approximation of the final pressure is obtained, the values of the exponent (n) in the equation $P_1V_1^n = P_2V_2^n$ may be estimated for short intervals of the curve and the final pressure calculated with considerable accuracy.

The value (n) for that part of the compression, from volume .098 to volume .085, is estimated by comparing the distance of the starting point from one of the adiabatics with the distance between the two adiabatics measuring in each case along the .1 cu. ft. line and then making proper correction; giving in this instance the value (n) = 1.747. For the last part or from .085 to .0695 the value (n) is 1.85.

The pressure at volume .085 is found to be 2558.

$2000 \times .098^{1.747} = P \times .085^{1.747}$; $P = 2558$.

The final pressure P_f is then figured from

$2558 \times .085^{1.85} = P_f \times .0695^{1.85}$. $\quad P_f = 3722$.

The pressure drops to 1550 lbs. at the start due to the cooling. The final pressure after compression is found by calculation to be 2879.

$1550 \times .098^{1.733} = P \times .085^{1.733} \quad P = 1983.$

$1983 \times .085^{1.85} = P_f \times .0695^{1.85} \quad P_f = 2879.$

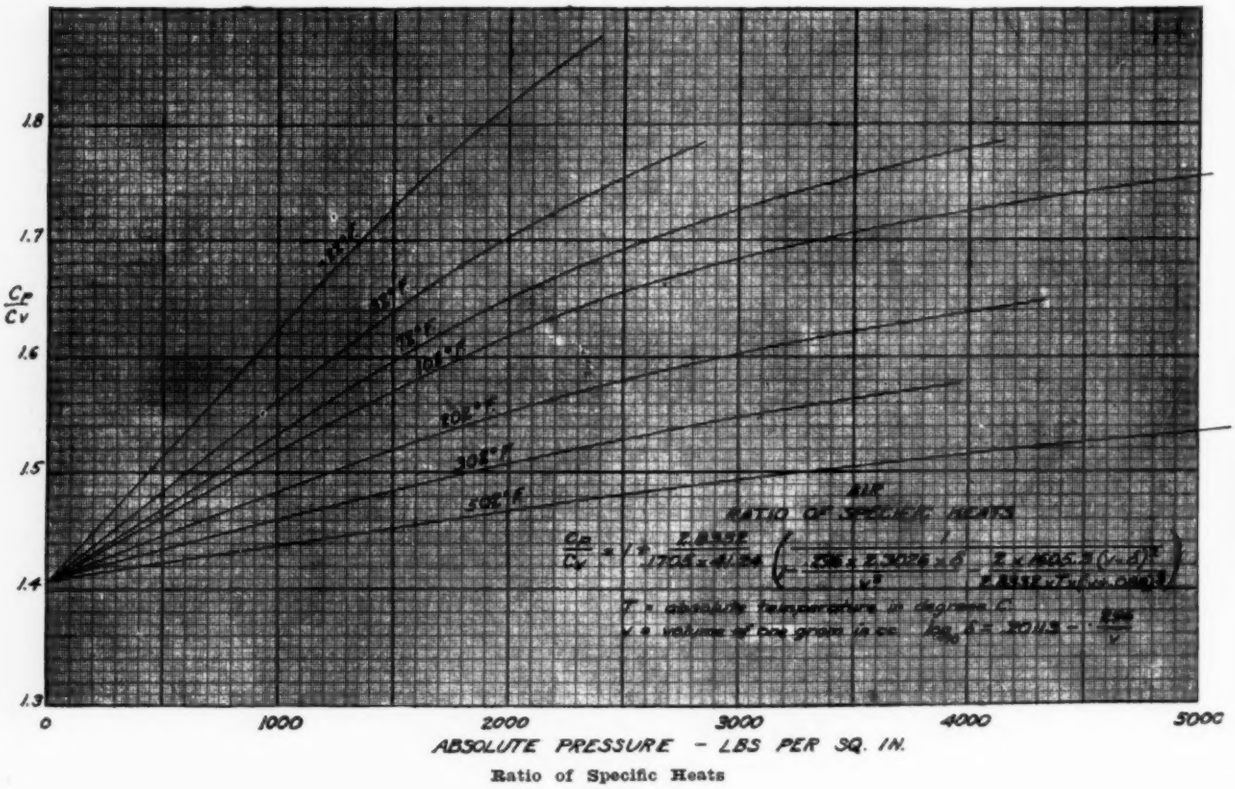
The work of compression is:

$$81.26 \left\{ \frac{2879 \times 144 \times .0695 - 1983 \times 144 \times .085}{.85} + \frac{1983 \times 144 \times .085 - 1550 \times 144 \times .098}{.733} \right\}$$

$= 699{,}770$ ft. lbs.

HAD the temperature of the atmosphere increased from 72° to 120° what would have resulted?

At 120° the absolute temperature is 580 approximately.



Ratio of Specific Heats

The work of compression may be calculated for one pound and the final result multiplied by the weight or the original volume of air may be taken and the weight factor dropped out.

The work of compression per pound is:

$$\frac{3722 \times 144 \times .0695 - 2558 \times 144 \times .085}{1.85 - 1} + \frac{2558 \times 144 \times .085 - 2000 \times 144 \times .098}{1.747 - 1}$$

$= 11{,}130$ ft. lbs.

Multiplying by the weight

$$81.26 \times 11{,}130 = 904{,}420 \text{ ft. lbs.}$$

SUPPOSE that the temperature of the atmosphere dropped to 440° absolute or to practically 20 degrees below zero Fahrenheit, what is the effect on the air in the recuperator?

The original pressure of 2000 lbs. at 72° would have increased to 2230 lbs.

The final pressure is calculated using values of n as 1.75 and 1.845 as 4147 lbs. and the work of compression becomes 1,007,500 ft. lbs.

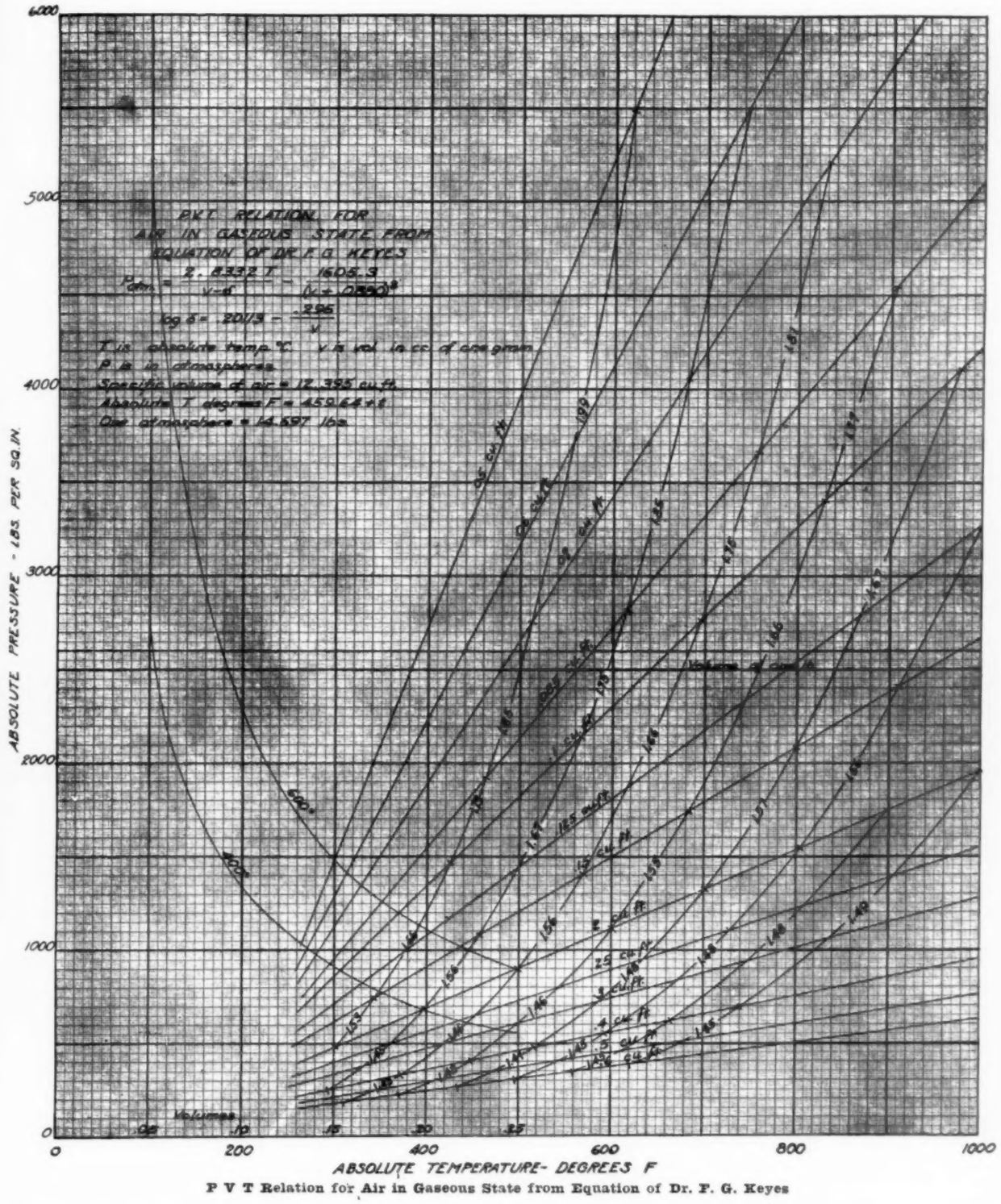
HAD the compression curve been assumed as an hyperbola the work of compression at 72° with original pressure of 2000 lbs. absolute figures as

$$81.26 \left\{ 2000 \times 144 \times .098 \times 2.3026 \log_{10} \frac{.098}{.0695} \right\}$$

$= 788{,}130$ ft. lbs.

which is 116,290 ft. lbs. less than adiabatic or 12.8 per cent. in error.

Had the compression been assumed as adiabatic for a



P V T Relation for Air in Gaseous State from Equation of Dr. F. G. Keyes

"perfect gas" with initial pressure 2000 lbs. abs. at 72° the final pressure would appear to be 3240.

$2000 \times .098^{1.404} = P \times .0695^{1.404}$. $P = 3240$.

The work of compression 845,400 ft. lbs.

The work required for an adiabatic compression of a *perfect gas* may be figured accurately by multiplying the specific heat C_v by the weight, by the increase in temperature and by 778.

As the departure from a perfect gas becomes evident this method is not applicable. With compression to high pressures the increase in temperature is much greater than for a perfect gas.

Summary

Temp. at Start	Pressure lbs. ab. sq. in. Start	Pressure lbs. ab. sq. in. End	Volume cu. ft. Start	Volume cu. ft. End	Kind of Compression	External work required for Compression
72°	2000	3722	7.9664	5.6516	Adiabatic for air.	904,420
— 20°	1550	2879	7.9664	5.6516	Adiabatic for air.	699,770
120°	2230	4147	7.9664	5.6516	Adiabatic for air.	1,007,500
72°	2000	2820	7.9664	5.6516	Isothermal for perfect gas.	788,130
72°	2000	3240	7.9664	5.6516	Adiabatic for perfect gas.	845,400

Air

Cu. ft. per lb. *Weight Air*	Press. in Atmospheres at Temp. of 491.64 Abs. °F.	Lbs. / sq. in. Abs. at Temp. of 491.64 Abs. °F.	Press. in Atmospheres at Temp. of 983.28 Abs. °F.	Lbs. / sq. in. Abs. at Temp. of 983.28 Abs. °F.
.05	262.94	3864.	682.55	10031.
.06	210.52	3094.	530.16	7792.
.07	176.28	2591.	433.34	6369.
.085	142.80	2089.	340.77	5008.
.1	120.53	1771.	281.14	4132.
.125	96.13	1413.	218.04	3205.
.15	80.151	1178.	178.27	2620.
.2	60.317	886.5	130.79	1922.
.25	48.420	711.6	103.36	1519.
.3	40.425	594.1	85.375	1255.
.4	30.474	447.9	63.504	933.3
.5	24.453	359.4	50.544	742.8
.6	20.428	300.2	41.975	618.3
.8	15.355	225.7	31.351	460.8
1.0	12.305	180.8	25.021	367.8
2.	6.174	90.75	12.452	183.0
3.	4.121	60.57	8.289	121.8
5.	2.475	36.38	4.967	73.00
8.	1.548	22.75	3.102	45.60
12.	1.032	15.17	2.065	30.35

Ratio of the Specific Heats of Air $= \frac{C_p}{C_v}$

Press. in Atmos.	t = 32° F. T = 491.64 Press. lbs. abs. sq. in.	$\frac{C_p}{C_v}$	Press. in Atmos.	t = — 22° F. T = 437.64 Press. lbs. abs. sq. in.	$\frac{C_p}{C_v}$	Press. in Atmos.	t = 72° F. T = 531.64 Press. lbs. abs. sq. in.	$\frac{C_p}{C_v}$
194.87	2864.	1.785	162.91	2394.	1.875	314.27	4618.	1.786
93.50	1374.	1.622	80.78	1187.	1.663	218.54	3212.	1.739
53.89	792.0	1.528	11.34	166.4	1.435	103.40	1520.	1.598
12 80	188 1	1 431	5 71	83 91	1 419	58 93	866	1 516
6 42	94 35	1 417	.983	14 47	1 406	13 88	204	1 429
1.10	16 17	1 405				1.195	17.56	1.405

Values of $\frac{C_p}{C_v}$ for Temperatures 102°F, 202°F, 302°F, and 502°F

Pressure in lbs. per Atmos.	sq. in. ab.	$\frac{C_p}{C_v}$ 102° F.	Pressure in lbs. per Atmos.	sq. in. ab.	$\frac{C_p}{C_v}$ 202° F.
43.993	646.5	1.4777	52.15	766.4	1.4652
98.23	1443.	1.5650	105.96	1557.	1.5226
127.46	1873.	1.6061	224.87	3305.	1.6150
149.65	2199.	1.6358	294.25	4325.	1.6467
183.10	2693.	1.6691			
342.72	5073.	1.7554			

Pressure in lbs. per Atmos.	sq. in. ab.	$\frac{C_p}{C_v}$ 302° F.	Pressure in lbs. per Atmos.	sq. in. ab.	$\frac{C_p}{C_v}$ 502° F.
2.3989	35.26	1.4046	3.0304	44.54	1.4046
60.04	882.4	1.4558	77.976	1146.	1.4440
183.73	2700.	1.5390	240.36	3533.	1.5063
269.75	3965.	1.5784	356.87	5245.	1.5359

Values of $\frac{1}{V-\delta}$ Used in Making Plot from Which to Determine Values of Integral $\frac{dv}{V-\delta}$ Between Limits

$$\text{Log} = .20113 - \frac{.296}{V}$$

V in cc.	$\frac{1}{V-\delta}$	V in cc.	$\frac{1}{V-\delta}$	V in cc.	$\frac{1}{V-\delta}$	V in cc.	$\frac{1}{V-\delta}$
2	1.150	10	.1174	18	.0607	100	.0102
3	.5767	11	.1052	19	.0572	200	.0050
4	.3796	12	.0953	20	.0542	300	.00335
5	.2768	13	.0870	25	.0426	400	.00251
6	.2183	14	.0801	30	.0352	500	.00201
7	.1799	15	.0742	35	.0299	600	.00167
8	.1529	16	.0691	40	.0260		
9	.1329	17	.0646	50	.0206		

V_1 cc.	V_2 cc.	V_2 cu. ft.	$\frac{MR}{C_v}\left\{\frac{dv}{V-\delta}\right.$	$\frac{T_1}{T_2}$	$T_1 = 540°$ F. T_2	$T_1 = 720°$ F. T_2	$T_1 = 900°$ F. T_2	$T_1 = 1080°$ F. T_2
4	8	.1282	.37586	1.4562	371	495	619	742
4	12	.1925	.56814	1.7649	306	408	509	612
4	16	.2565	.69805	2.010	269	358	448	537
4	28	.449	.94255	2.567		281	351	421
4	40	.641	1.0944	2.987			301	362
4	60	.961	1.2628	3.532			255	306
4	80	1.281	1.3819	3.981			226	271
4	100	1.602	1.4738	4.365				247
4	140	2.222	1.6106	5.006				
4	180	2.883	1.7121	5.540				
4	220	3.525	1.7934	6.010				
4	260	4.170	1.8611	6.430				
4	300	4.800	1.9193	6.816				
4	340	5.440	1.9702	7.172				
4	380	6.090	2.0155	7.505				
4	420	6.730	2.0567	7.820				
4	460	7.370	2.0943	8.120				
4	500	8.020	2.1285	8.403				

The Value of M Used in the Above is $\frac{1}{41.24}$ One Calorie Being Equivalent to 41.24 C. C.—Atm.

$T_1=1260°$ F. T_2	$T_1=1440°$ F. T_2	$T_1=1620°$ F. T_2	$T_1=1800°$ F. T_2	$T_1=1980°$ F. T_2	$T_1=2160°$ F. T_2	$T_1=2340°$ F. T_2	$T_1=2520°$ F. T_2	$T_1=2700°$ F. T_2	$T_1=2880°$ F. T_2
866	990								
713	816	918	1020						
626	716	804	896	985	1074				
492	561	630	701	770	842	912	981		
421	482	541	603	663	723	784	843	904	964
357	408	459	510	561	612	663	715	765	816
316	361	407	452	497	543	588	634	677	724
288	330	371	412	453	495	536	577	618	660
252	288	324	360	396	432	468	504	540	576
228	260	292	325	358	390	423	455	488	533
	240	270	300	330	360	390	420	450	480
		252	280	308	336	364	392	420	448
			264	290	317	343	370	396	422
				276	302	327	352	377	402
					288	312	336	360	384
						299	322	345	368
						288	311	332	355
							300	322	343

Pressures and Volumes for Adiabatic Shown on P V T Plot

Vol.	Pressures								
6	....	....	185	225	265	305	345	385
5	....	....	....	....	....	....	....	....
4	....	250	330	405	475	550	620	695
3	....	375	495	605	720	835	940	1060
25	....	500	650	800	950	1100	1235	1390
2	480	685	900	1115	1325	1540	1740	1960
15	740	1075	1410	1740	2080	2410	....	....
1	1450	2120	2760	3405	4100	....	....	....
085	1920	2820	3660	4540	....	....	....	....
07	2750	4040	5200	....	....	....	....	....
05	5480	....	....	....	....	....	....	....

Army Nomenclature

THE Army Almanac in explaining the origin of army titles says that a captain commands a company and his title is derived from the Latin word for head—"caput." His second in command was his lieutenant, the man who held (tenant) the company in place (lieu) of the superior officer. Next came the sergeant, one who served (servir). Several companies together form a column commanded by a colonel (column). The spelling still exists, although the pronunciation was changed long ago. The titles of the other two field officers were taken from the company titles as roots, and the second in command became a lieutenant colonel, and the third in command became a sergeant major, or big sergeant. The word sergeant was dropped several hundred years ago and this officer became a major.

The whole army, many columns, was commanded by a colonel general. Gradually the colonel was dropped and he became a general. His second in command was a lieutenant general, and again the company sequence was used and the third officer was a major general. The fourth general officer was given the name of the unit larger than a regiment, the brigade, brigadier.

Company comes from bread (pain) and together (con). They eat bread together. The regiment is the unit under the regime of an officer. Brigade is a troop or crew of many together. Corps means body (of men). Division was originally part of an army, now of an army corps. Platoon means ball or group (of men), a squad is a square and a battalion is really a body of troops in battle formation.

Silver Fulminate, an Initiator of Detonation[1]

By

C. A. TAYLOR and E. P. BUXTON

THE detonating properties of silver azide, AgN_3, were given in a previous article[2], and subsequent articles will give the properties of other silver compounds investigated.

Silver fulminate is not new, as it was first prepared by Howard[3] in 1800. This product, $Ag_2C_2N_2O_2$, has been confused in the literature with "fulminating silver," a black silver salt that can be prepared by the action of ammonia on silver oxide. Fulminating silver is very sensitive and sometimes detonates when moist. It is similar to the better known nitrogen iodide and has been the cause of accidents in recovering silver from photographic solutions.

Method of Preparation

Howard prepared silver fulminate by dissolving 40 grains of silver in 2 ounces of concentrated nitric acid diluted with an equal volume of water and treating with 2 ounces of alcohol. A yield of 60 grains of silver fulminate was obtained.

We tried various ratios of the materials and found that it was advisable to use 6 cc. of 66 to 70 per cent, HNO_3, to each gram of silver, Ag. The silver dissolved in the acid, but at least 1 cc. of water was necessary to each 5 cc. of nitric acid, HNO_3, in order to keep the silver nitrate, $AgNO_3$, in solution. We used 15 cc. of 95 per cent alcohol to each gram of silver, Ag.

The silver was dissolved in the diluted nitric acid, by placing the beaker containing the mixture in a water-bath. The temperature of the solution was usually about 90° to 95°C when the silver was all dissolved. The alcohol was placed in a large flask under a hood and the hot $AgNO_3$ solution was poured into it. The temperature of the mixture was then about 70°C and the reaction *usually started*. If there is sufficient material present, enough heat is evolved to maintain the reaction temperature. A temperature of at least 60°C seemed to be *necessary for the reaction.*

If the reaction stops it may be started by immersing the flask in hot water. If it becomes too rapid it may be checked by adding cold water or cooling in a bath of cold water.

A precipitate of fine needlelike crystals begins to settle out in from 2 minutes to an hour or more, depending upon the speed of reaction. Under favorable conditions practically the theoretical yield of silver fulminate was obtained from the Ag used.

The precipitate was filtered off, washed with water until acid-free, and dried in the same manner as mercury fulminate. All of the precipitates obtained were composed of fine crystals, even when the temperature was kept so low that it took 2 hours to complete the reaction. It is better, however, to have the conditions such that the reaction will be completed in 15 minutes. The proportion of water advisable to add to the acid varies with the quantity of materials used. The minimum quantity of water to keep the silver nitrate, $AgNO_3$, in solution is best if only a gram or two of silver is used, but if an ounce or more of silver is used more water is necessary to keep the reaction from becoming too rapid.

Properties

The silver fulminate produced consisted of fine colorless colloidal aggregates over 0.2 mm. in length and 0.01 mm. in diameter. It is slightly soluble in the ordinary solvents, as shown by the following tests:

Solvent	Fulminate dissolved per 100 grams of solvent, grams
Water	0.016
Ether	0.015
Acetone	0.012
95 per cent alcohol	0.010

Silver fulminate is not hygroscopic, as shown by the low solubility. It is practically the same as mercury fulminate in this respect, but unlike the latter it does not collect enough moisture when stored in a damp place to reduce its detonating efficiency.

The effect of absorbed moisture on the detonating efficiency of silver fulminate was determined by loading No. 8 detonating capsules with 0.4-gram charges of TNT and pressing charges of silver fulminate, with a reinforcing cap over it, and testing these before and after remaining for some time in a desiccator over water; 0.07 gram of silver fulminate was required to detonate TNT, so an excess was used.

Sand crushed by 0.4-gram charges of TNT, with indicated weights of silver fulminate, dry, was as follows:

$Ag_2C_2N_2O_2$, grams	Sand crushed, average grams
0.200	38.5
0.150	37.0
0.100	36.0

[1]Published by permission of the Director, U. S. Bureau of Mines.

[2]Taylor, C. A., and Rinkenbach, Wm. H., ARMY ORDNANCE, Vol. 5, p. 824 (1925).

[3]Transactions of the Royal Society, Part I, p. 232 (1800).

Sand crushed by 0.4-gram charges of TNT with indicated charges of silver fulminate, after storage for 34 days over water, was as follows:

$Ag_2C_2N_2O_2$, grams	Sand crushed, average grams
0.200	35.5
0.150	37.0
0.100	39.0

The actual increase in weight was only about a milligram. The maximum fall of the 500-gram weight in the impact test that did not cause the detonation of mercury fulminate in three trials was 127 mm., while for silver fulminate it was 327 mm. Colver[4] gives 130 mm. as the height required for mercury fulminate.

The strength of silver fulminate is about the same as mercury fulminate, as shown by the following sand test:

Charge, grams	*Grams of sand crushed by charge of* Silver fulminate	Mercury fulminate
0.100	1.9	2.4
0.200	5.6	3.4
0.300	8.4	7.6
0.400	12.4	12.2
0.500	16.3	15.3
0.600	20.2	20.2
0.800	27.9	28.1
1.000	35.2	35.0
1.500	54.6	55.1

Silver fulminate is more efficient than mercury fulminate as an initiator of detonation; 0.4 gram of TNT was loaded into No. 6 detonator capsules, and the minimum weight of mercury fulminate and silver fulminate required for its complete detonation was determined by the sand crushed in the sand test bomb.

When the charges were not confined by a reinforcing cap it required 0.14 gram of silver fulminate as compared with 0.35 gram of mercury fulminate; when a reinforcing cap was used it took 0.07 gram of silver fulminate and 0.24 gram of mercury fulminate.

Silver fulminate is stable at ordinary temperatures. It did not show appreciable loss in weight or signs of decomposition after heating for 10 days at 50°C. Exposed to air it turns from pure white to a light brown in a few days, but this does not apparently mean decomposition, as the properties are unaffected. A. M. Peter[5] examined a sample of silver fulminate that had been stored for at least 37 years under water, and found that it detonated strongly by striking or heating and no decomposition had occurred. The sample was crystalline and slightly brownish.

Silver fulminate detonated at 235°C with a sharp report both when dropped on the surface of a metal bath at that temperature, also when placed on the metal at a lower temperature and the temperature increased to that point.

Summary

Silver fulminate is a stable compound very similar in its properties to mercury fulminate, but is more efficient as a detonating material. However, this advantage is not enough to make up for the difference in cost at the present time.

The current market price for silver is 68 cents an ounce against 7 cents an ounce for mercury, or say 1/10 that of silver; and even though the relative detonating efficiency of mercury is about 1/3 that of silver, the balance is still well on the side of mercury.

[4]High Explosives (Van Nostrand) (1918), p. 528.

[5]Journal Amer. Chem. Soc., Vol. 38, p. 486 (1916).

The Ordnance Department Reference Library

SINCE the establishment of the Ordnance Department as an arm of our military forces, its Reference Library has been one of the important parts of the organization. Each year the Library purchases new books on technical, scientific, military and other subjects, including industrial mobilization and plans, which are selected from publishers' lists and book reviews, upon recommendation by officers and employees of the Ordnance Department. The Library now has on its shelves about 5,000 volumes, exclusive of bound periodicals.

The Library receives nearly 100 technical and trade journals, and maintains a classified list showing the branch of science or technique treated by each periodical. There is a unique system of keeping informed on matters of information published in periodicals through a system of reviews by designated readers. Articles of interest to the various sections of the Ordnance Department are abstracted by these reviewers and are indexed in the Library for future reference.

In addition to its collection of books and periodicals the Library also maintains a special file of ordnance technical manuscripts which includes lectures, articles and technical reports written by officers and employees of the Ordnance Department. A separate series of the technical manuscript file has been made for the Watertown Arsenal experimental reports and also for ballistic data, the aim being to have available and properly catalogued all ordnance literature.

The Library also contains a collection of about 3,100 lantern slides and over 100 motion picture reels of ordnance matériel which are used as illustrations for lectures given by ordnance personnel throughout the country. Among the special collections are files of about 540 ordnance histories, some 1,200 trade catalogs and a file of miscellaneous pamphlets and clippings from newspapers and magazines. Here also are maintained firing records, reports of boards on special tests, and other special records not for general circulation, all of which are filed in what is known as "the firing record room" which is, in fact, a separate department of the Library.

Besides its own collection of information, the Library has the privilege of borrowing from the Library of Congress, the Public Library of Washington, and all libraries maintained by other Government Departments. Its index contains many cards for publications which are in outside libraries, thus extending its information service beyond its own shelves.

In an organization where technical and engineering data are constantly in use it can readily be seen that the Ordnance Department Reference Library performs a very important function.

The Behavior Under Stress of the Iron Crystals in Steel

Part I

By

H. H. LESTER and R. H. ABORN

THE objects of the investigations described in this paper were: to obtain information regarding stress and strain values in the crystals of steel under tension up to the yield point for the steel and after the steel has been subjected to plastic deformation; to study the effect of carbon content and the effect of heat treatment on those values; to obtain such other information that might develop during the course of the experimentation and that might have important bearing on problems in connection with the auto frettage method of manufacturing guns.

The conclusions reached are:

1. The crystals in the crystalline aggregate that constitutes steel follow a different stress-strain curve from that of the crystalline aggregate.

2. In the elastic region for the aggregate the crystals undergo irregular deformations for applied stresses though the trend of the stress-strain curve is similar to that for the aggregate.

3. The irregularities noted indicate that the crystals undergo occasional strain recoveries during the application of stress.

4. The strain recoveries in the elastic range of the aggregate may be explained as the result of "stepped slip." Stepped slip is defined as small movements of atmos along planes of slip relative to atoms in adjacent planes of the same planar system after which movement the atoms are left in the same geometrical configuration relative to adjacent atoms that they had before the movement started.

5. On account of strain recoveries the crystals show no characteristic irregularity in deformation that may be associated with the stress value which defines the proportional or the elastic limit of the crystalline aggregate. Similarly there is no irregularity in the crystal deformations that may be associated with the yield point, but this fact is ascribed to the strain recoveries that may occur due to block slip where block slip is defined as slip along glide planes in the crystals that leave the atoms in other than the geometric configurations relative to adjacent atoms which they had before the motion started.

6. Because of the strain recoveries described above the crystals are in no greater strain and under no greater stress after plastic deformation than they were immediately before and in some cases, at least, may be under less stress and in less strain.

7. For stress values below the proportional point for the aggregate the elastic load on the aggregate is taken by the iron crystals, within the limits of accuracy for the experiments. For stress values above the proportional point some of the stress appears to be taken by structures in steel other than the iron crystals.

8. It is assumed that the other structure appearing for loads on the aggregate above the proportional point are regions of disorganized material in which the atoms do not have the geometric organization that is characteristic of perfectly crystalline material. It is further assumed that this disorganized material is the result of block slip and that the regions of disorganization occur along the planes of block slip, the region of disorganization forming essentially a plane of rupture.

9. Deduction from the above facts and assumptions leads to the conclusion that the changes in the physical properties due to plastic deformation may be ascribed to the breaking up of crystals into smaller crystals with the formation of disorganized material that is not perfectly elastic, but which serves to stiffen the resistance of the material to deformation.

10. High carbon sorbitic steel has a lower crystal modulus than low carbon sorbitic material which in turn has a lower modulus than high carbon pearlitic material.

11. The alpha iron crystals of sorbitic steel are distorted, the amount of distorted crystals being greater for the higher carbon material. The pearlitic material does not show evidences of distortion in the alpha iron crystals.

12. The above facts indicate that the carbon is in solution with the alpha iron crystals in the sorbitic material, but is not in solution in the pearlitic material.

13. The probable distribution of carbon in the iron-carbon solution is one in which a carbon atom displaces one iron atom in the alpha iron lattice and associates itself with three adjacent iron atoms to form a molecule of iron carbide, the four atoms of the carbide molecule replacing four iron atoms and occurring near to, but not on, the lattice points of the alpha iron crystals. This solution may be described as a "molecular dispersion of iron carbide in alpha iron." The solution is probably not stable, but possesses pseudo-stability due to the high viscosity of alpha iron at ordinary temperatures.

14. As a consequence of the above distribution of carbon in the alpha iron crystals, these crystals should resist slip to a greater extent than pure iron crystals, thus enabling the crystals to withstand greater stresses than

pure iron crystals. At the same time the lower modulus enables the solution crystals to be deformed to greater extents for the same stresses than pure iron crystals and for this reason reduces the probability for the starting of incipient cracks in the material when subjected to overstrain.

15. A general deduction may be made as to stress and strain distributions in steel from the facts and particular deductions of these experiments somewhat as follows: Steel owes its strength to the nature of the atomic bonding, and to influences that tend to prevent slip of the atoms along glide planes. These influences may be the mutual interference between adjacent crystals, the effect of distorted crystal planes due to dissolved carbide, the effect of disorganized material formed during plastic deformation, and possibly other effects not found in these experiments. The proportional point of the crystalline aggregate may be defined as the region of stress values for which the stepped slip begins to merge into block slip and the yield point may be regarded as the region of stress values for which there is well defined block slip.

In order to present the matter more clearly a description of the materials used, the experimental methods employed, and the results found have been written in the form of a paper, which will appear serially in this journal. Unfortunately, the descriptions and voluminous data are of necessity so lengthy that their presentation here must be spread over several instalments. It is hoped that this method of presentation will affect the continuity of the text as little as possible.

Introduction

STEEL, the most important structural material of modern industry, owes its practical value in construction to its rigidity, its high tensile strength, its resistance to fracture by sudden shocks, and its malleability. Patient researchers over many years have had for their object the improvement of these desirable qualities in steel and have been responsible for the very remarkable developments that have been made. In order to facilitate further improvements it seems necessary to delve more deeply into the fundamental structures that are responsible for the essential properties of steel that are to be improved. This paper presents the results of an attempt to investigate the behavior under stress of the elementary structures in steel. In particular it was desired to determine the changes in the atomic arrangements that occur when steel has been stressed up to the proportional point and beyond. Incidentally it was hoped to pick up additional information that might throw more light on the fundamental factors that govern such properties as elastic moduli, tensile strength, and the effect on such properties of added carbon in the steel.

Metallurgical investigations in which atomic displacements are measured directly are possible only by making use of the new and as yet more or less untried tool that is provided in the X-ray diffraction machine. The experiments here reported serve to illustrate such X-ray applications and to indicate the possibilities and present limitations of the X-ray method for this kind of research.

The paper is divided into the following main headings: 1. Materials Investigated; 2. Methods of Measurement; 3. Experimental Results; 4. Discussion of Results; 5. Summary of Conclusions.

Materials Investigated

The material that is most interesting and important to the Ordnance Department and to most structural engineers is steel. In order to obtain in this first study a somewhat comprehensive view of stress-strain relations in different steels the materials were selected to include widely differing carbon contents and widely differing metallographic structures. It was necessary to use thin ribbon rather than specimens of heavy section in order to make possible the penetration of the specimens by the X-rays. Three types of steel strip were investigated, they were:

A—Blued shim stock .003″ in thickness;
B—The same material as A, but carefully annealed;
C—Low carbon steel ribbon, thickness .002″.

A—Blued stock:

The chemical analysis was as follows:

Carbon	1.13%
Manganese	.19%
Silicon	.035%
Sulphur	.009%
Phosphorus	.015%

In processing the material, final treatment had been given at a blueing temperature, probably to retard surface corrosion and to temper it slightly, though it still was so stiff it failed under a sharp bend of more than 120°.

B.—Annealed Shim Stock:

A strip of blued stock 24 inches long and 1½ inches wide was made up into a coil 1-inch across so that it would fit into the graphite thimble within an Arsem Vacuum Furnace. Under a pressure of 1.5-mm. of mercury, the coil was subjected to a temperature of 750° C. (determined by a Wanner Optical Pyrometer) for 15 minutes, and then cooled in the furnace. This treatment seemed to be the best available, for it gave satisfactory annealing without appreciable oxidation.

Two changes, however, were brought about by this treatment. When the coil was unwound, the material was so soft that it kinked unavoidably. This difficulty was removed by an initial loading of each specimen tested. The other change was a 10% decarburization, an analysis of the material showing 1.03% carbon.

C.—Low Carbon Steel Ribbon:

The analysis was as follows:

Carbon	0.15%
Manganese	0.49%
Silicon	0.025%
Sulphur	0.041%
Phosphorus	0.013%

This material had a bright finish, and despite the rolling, was comparatively soft, easily enduring a 180° bend about a 1/16-inch radius.

Methods of Measurement

A.—*Mechanical Tests*

Stress-strain curves were obtained for the different materials by two methods. In the first the ribbon strips were suspended in an improvised vertical tension machine and loaded by the addition of lead shot to a bucket hung from the lower end of the ribbon. Special clamps were made for gripping the metal strips that were designed to give

uniform distribution of load. Extensions were measured by an optical lever that permitted an accuracy of measurement of 1%. Care was taken in these and in all subsequent tests to avoid subjecting the metal to shocks. On account of the fact that consistently low modulus values were found with the annealed material a second method was adopted in which the specimens were mounted in a horizontal testing machine. A diagram of the apparatus is shown in Fig. 1. In this case the loads were applied by adding

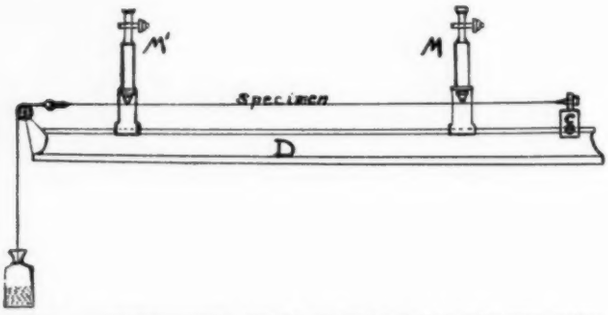


Fig. 1. Diagrammatic sketch of horizontal tensile apparatus used for getting stress-strain curves for the steel strips. M and M' are micrometer microscopes.

mercury to a container that was attached to the test specimen by means of a cord that passed over a pulley. Extensions were measured by means of two micrometer microscopes. Light clamps were used to grip the material and these were supported to reduce the sag in the ribbons. There was some sag due to the weight of the ribbons themselves, but the error introduced from this fact was negligibly small. The moduli determined by this method checked with those found by the first method and had the same accuracy.

B.—*X-Ray Tests, Strain Measurements*

The theory of X-ray diffraction has been described in various publications[1] and will be touched on here only to the extent necessary to bring out its application to the details of this investigation. When metal solidifies the atoms tend to seek positions of stability under the atomic forces. The configurations of stability thus formed give geometric arrangements the unit structure of which is called the unit crystal or the space lattice of the crystal. The indefinite repetition of the unit crystal gives the crystal of the metal with which the metallographist is familiar. In iron at ordinary temperatures the unit crystal is a cube with an atom at the center. It is called a body-centered cube. The cube edge is 2.86 angstrom units in length.[2]

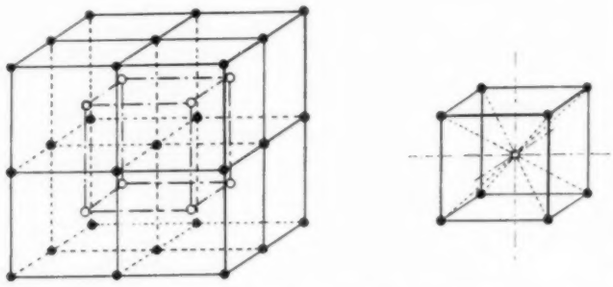


Fig. 2. Iron crystals showing relative positions, but not relative size of the iron atoms. Lattice, or unit crystals, shown on right, crystal with eight units on left. Each atom is equally distant from eight other atoms disposed at the corners of a cube. This type of lattice is called the "body centered cubic," any atom may be regarded as either a corner or a center atom. In this diagram the corner atoms are indicated by solid circles.

Due to the definite geometric arrangement in the crystal, the atoms fall into a series of parallel planes inclined at different angles to the cube edges, each plane system including every atom of the crystal. The unit structure and the plane systems used in the present study are illustrated in Figs. 2 and 3. The plane systems are designated by Miller indices[3], except that one index is used to designate

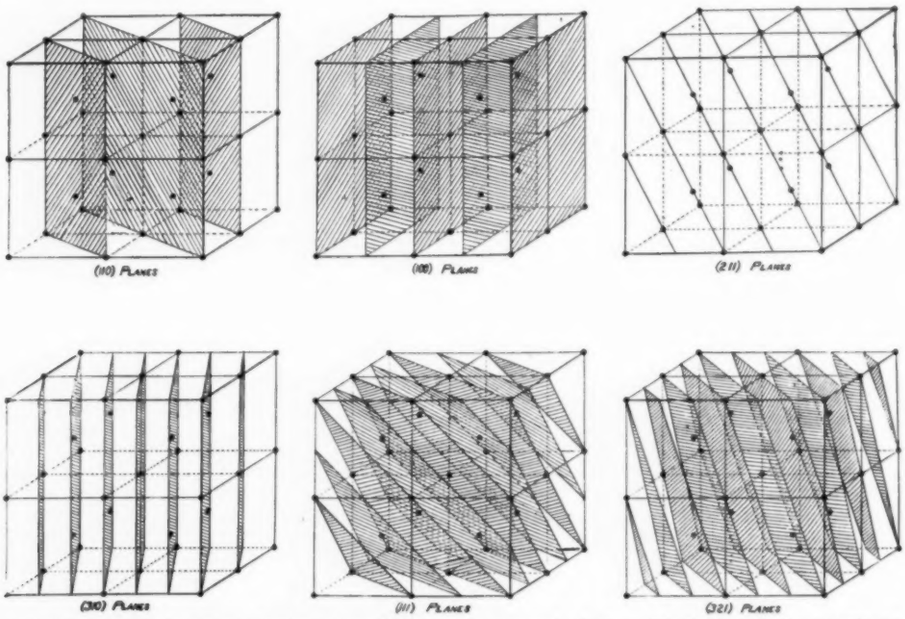


Fig. 3. Atomic Plane Systems involved in the present study. Circles mark the positions of the atoms, but do not indicate their size.

[1] One of the best descriptions is that by Dr. A. W. Hull. Gen. El. Rev., Jan., 1917; also Phys. Rev. Vol. X, p. 661, 1917.

[2] 1 angstrom — 10^{-8} cm.

[3] For description of Miller indices see "Structure of Crystals," Wyckoff, page 47.

one plane system and its conjugate systems. For example, the basal plane systems are in Miller index notation the (100), the (010), and the (001) planes. These are equivalent systems, having the same spacing, and record at the same place on the X-ray films. Since the crystal spectra do not distinguish between the conjugate systems only one index is used to designate the similar systems. Each of the sets of planes may be regarded as a space grating for X-radiation, where by a space grating is meant a stack of equally spaced reflecting planes of such order of spacing as to make possible interference phenomena in the reflections. The grating is analogous to the plane grating except that the lines of the plane grating are replaced by planes. The grating constant in the one case is the distance between lines and in the other is the distance between planes. The law for the space grating is

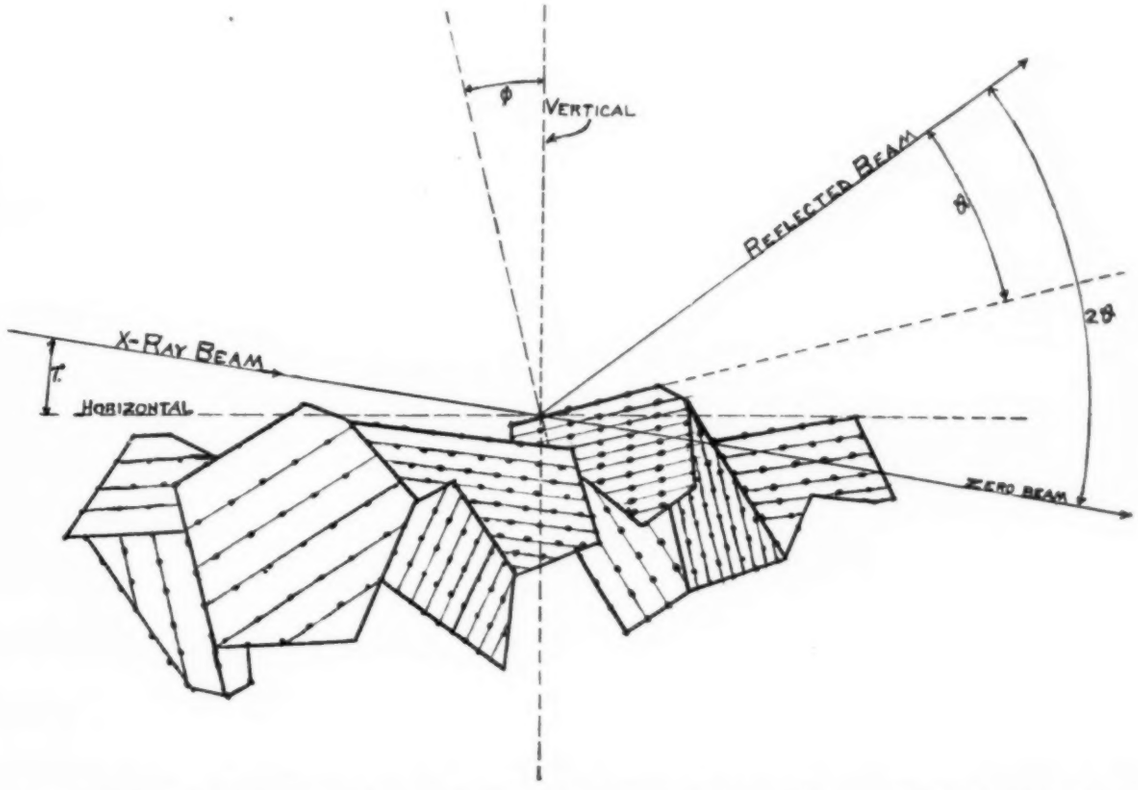


Fig. 4. Crystalline Aggregate—Diagrammatic representation showing the chaotic arrangement of crystals in ordinary metals. The X-ray beam shown here as a line is in reality a band covering many crystals in the vertical section, and reflections shown here from only one point in reality occur from many points throughout the section of material penetrated by the X-radiation.

similar to that of the line grating and is represented by the equation,

$$n\lambda = 2d \sin \Theta,$$

where $\lambda = 2d \sin \Theta$ (for 1st order reflections),

λ = wave length of the X-radiation,

d = interplanar spacing,

Θ = angle that the incident ray makes with the reflecting planes.

n = order of reflection.

Since in the crystal there are many possible sets of parallel planes, and consequently many possible space gratings, the crystal may be regarded as a compound space grating. If in the above equation λ be constant and if the crystal be rotated in the incident X-ray beam, reflections or diffracted images of the source of the radiation will be found for certain values of Θ. These values substituted in the above equation give values for "d," the perpendicular distance between planes. This quantity "d" is the particular distance that is determined in X-ray measurements, from the various values of this quantity for a crystal the dimensions and type of the crystal lattice may be obtained. The measurements in the present investigation were concerned chiefly with changes in "d." In most metals crystallization starts from many points and the crystals formed are small. In addition the crystals are broken into smaller sizes by forging, rolling, or other operations so that the metal as used ordinarily consists of an aggregate of small crystals that are held together by cohesive forces at the crystal surfaces. The small crystals usually have chaotic orientations. See Fig. 4. When an X-ray beam is passed through a mixture of very small crystals there will in general be groups of crystals in the mixture correctly oriented with respect to the X-ray beam to give reflections from each of the various possible plane systems. If the metal specimen is placed to intercept the X-ray beam and a photographic film placed to intercept the emergent radiation from the specimen it will show after proper exposure and development a series of images of the source of radiation. Where the incident radiation is limited by a slit system to a narrow flat beam the diffraction images will approximate straight lines and the array of these lines on the film constitutes the crystal spectrum. For purposes of illustration the spectrum "line" may be represented as the envelope of a series of

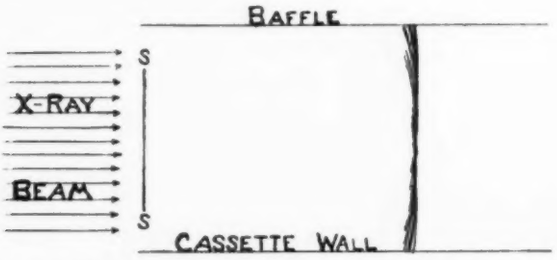


Fig. 5. Diagrammatic sketch showing the flat X-ray beam, the specimen, ss, and the "spectrum line" as it appears in the developed film. Note that the line is not sharp and may be represented as the envelope of a series of circles.

circles of equal radii and with their centers in a straight line, the character of the "line" is shown in Fig. 5. Fig. 6 represents a portion of the "crystal spectrum." A drawing is shown rather than a photograph because of the difficulty of reproduction of the X-ray negatives. In these experiments exposures of the kind described were made in a standard General Electric Co. X-Ray Diffraction Machine. The arrangement of the tube, slit system, specimens, and film is shown in Fig. 7. In order to further limit the X-ray beam an additional slit was provided in addition to those in the machine. This slit was .01-inch thick by 1.50-inches wide, was milled out of 1/32-inch copper sheet, and was placed in direct contact with the metal specimen. The radiation was obtained from a standard water-cooled molybdenum target X-ray tube. In the machine this radiation is passed through a ZrO_2% filter which absorbs all of the a_1 and the a_2 lines of the K radiation of molybdenum. The measurements were made from the a_1 lines, the wave length being $.708 \times 10^{-8}$ centimeters. The radius of the film holder, or cassette, was 8 inches. It is separated into two portions by a mid-baffle making it possible to place two specimens on the holder at the same time and obtain simultaneously spectra on the same film from each specimen. See Fig. 6. In these experiments one specimen was placed under tension and the other one was unstressed. The effect of the stress should be to cause increases in the value of "d" and consequently small changes in the positions of the spectrum lines. The measurements made were to determine the extent of these line shifts in comparison with the positions of the adjacent lines from the unstressed specimens that appeared on the same film. From the line shifts the extent of the crystal deformation was determined by calculation from the diffraction equation. To measure the line shifts, the films

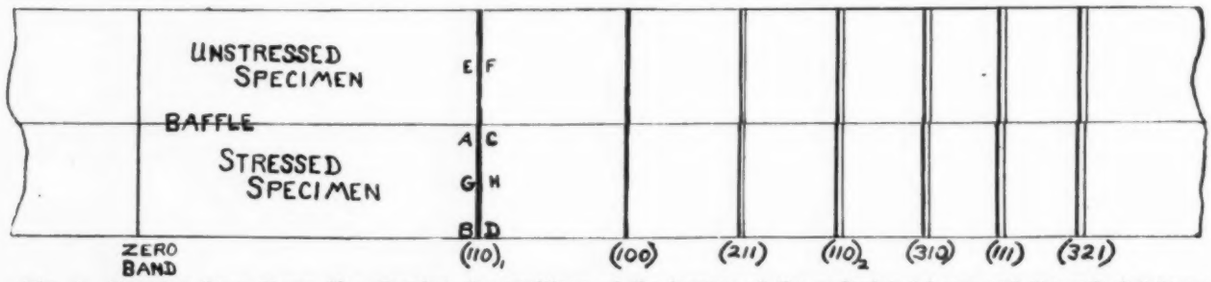


Fig. 6. Drawing from X-ray film showing the positions of the images of the undeviated beam and the reflected beams from the two specimens for the various plane systems. The spectrum lines are double because the X-radiation was not strictly mono-chromatic. The small shifts in the positions of the lines on the two sides of the film constitute the experimental evidence of the crystal deformations. The bracketed numbers refer to the plane systems from which the spectrum lines originated.

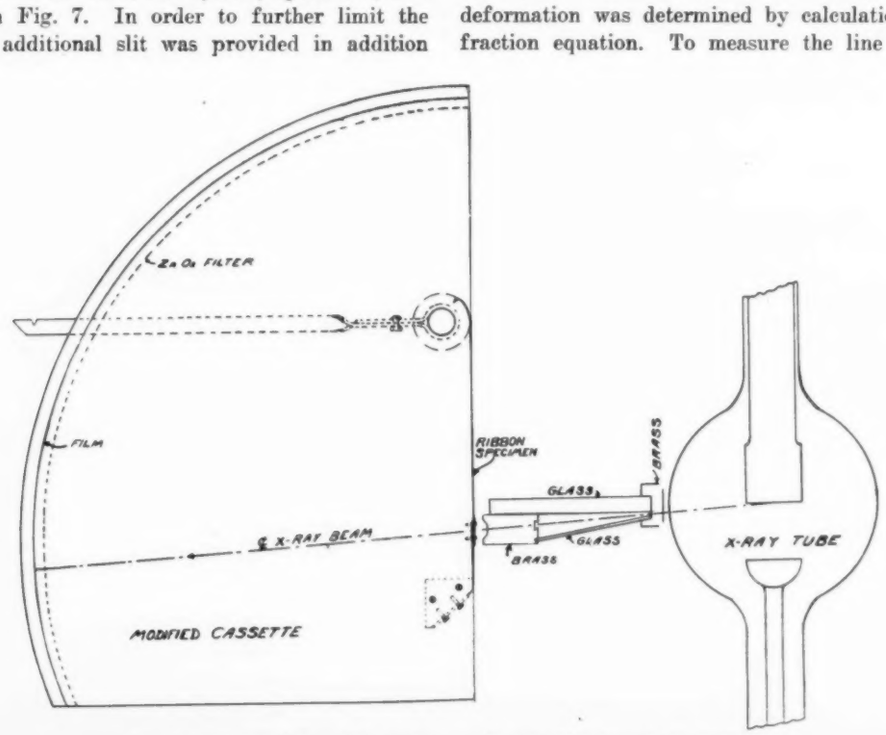


Fig. 7. X-ray tube, slit system, and cassette, drawn to scale.

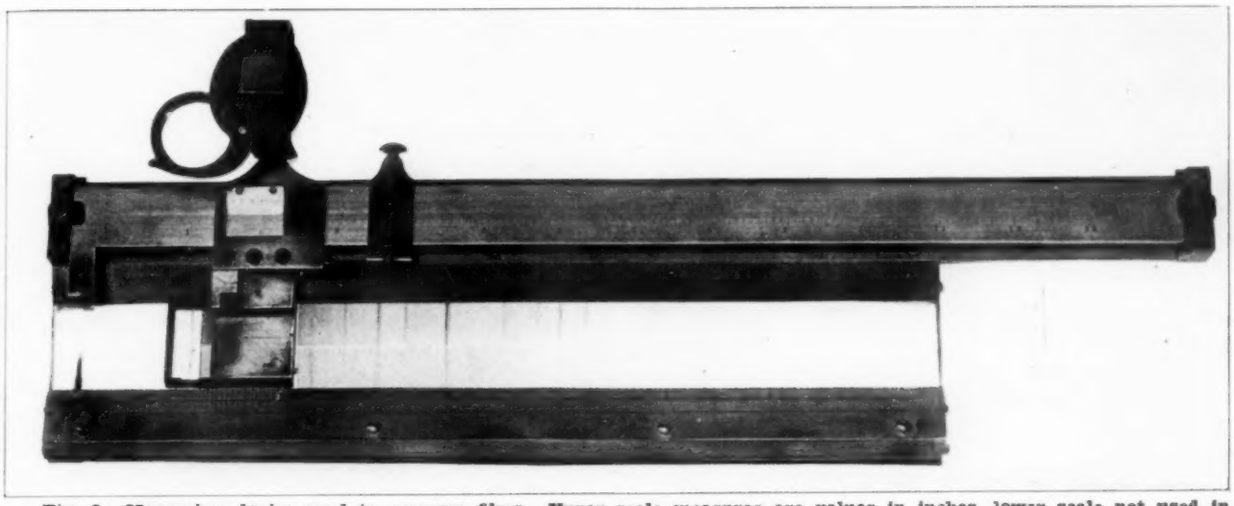


Fig. 8. Measuring device used to measure films. Upper scale measures arc values in inches, lower scale not used in these experiments measures values of "d" directly in angstrom units. This is a standard General Electric device to which the upper scale was added.

were mounted in a measuring device illustrated in Fig. 8. In this a 12-inch vernier scale reading to .001-inch is arranged on a frame that carries the film. The slider of the scale was provided with a 1 mil tungsten wire that served as a cross-hair for setting on the lines. The films were illuminated by transmitted light.

Stresses on the Iron Crystals

The specimens used were mounted on a cassette that was modified to accommodate a roller and attached lever arm. This is illustrated in Figs. 9 and 10, which show photograph and diagrams of the apparatus. The lever arm consisted of a steel arm (E) bent around the brass roller (B) to which it was made fast by a machine screw and nut. A slot was cut along (B) as shown to admit the upper end of the tension specimen, which was held in place by a wedge. The lower end of the specimen was held between the steel block (A) and the plate (P). (A) and (B) were lined up carefully to a vertical plane that passed about .01 inch outside of the axis of the cassette. The specimens passed behind the special slit mentioned above. The 1/32 inch copper from which the slit was cut was rounded off on the side next to the film, as shown in Fig. 10, so that the specimen was in contact with the metal only along the line of the slit, and was held accurately in the axis of the cassette by this copper piece.

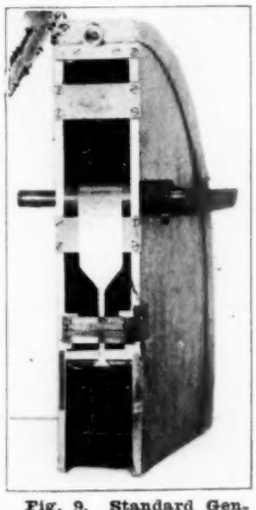


Fig. 9. Standard General Electric cassette as modified to accommodate the apparatus for applying tension to the specimens.

In preparing the specimens the chief consideration was to get uniform stress across the sections along the line of the slit. To accomplish

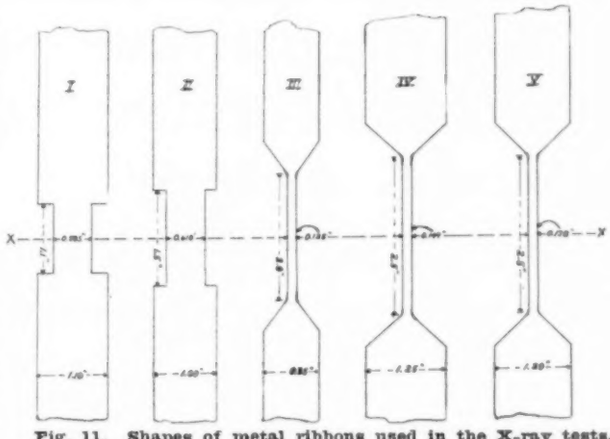


Fig. 11. Shapes of metal ribbons used in the X-ray tests. I and II were used for the tests on the blued stock, III, IV, and V, for the other materials.

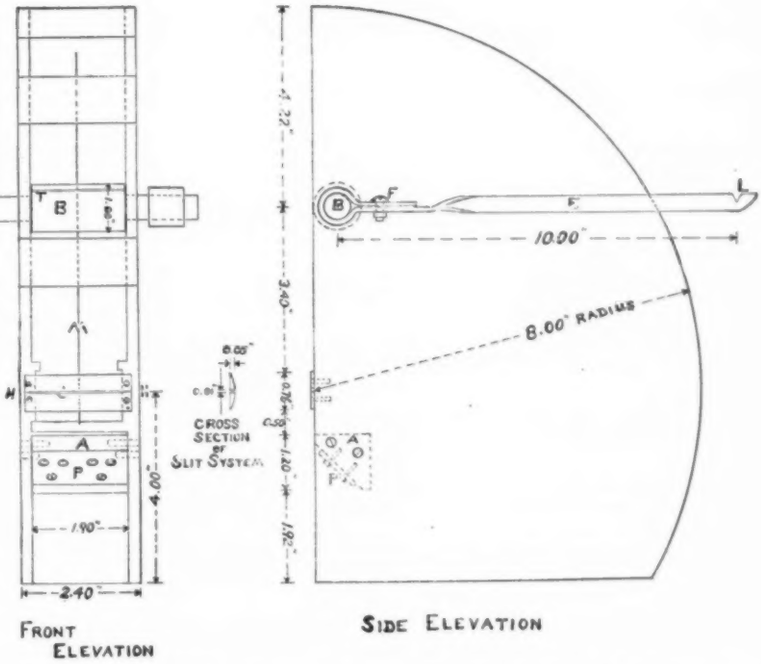


Fig. 10. Details of modified cassette showing at (E) lever arm, (B) roller, (T) slot in which specimens were fastened, (C) auxiliary slit, (A) metal block to which lower end of specimen was attached.

this the ribbons were cut into the shapes shown in Fig. 11. The tests with the blued stock were made with the wider specimens. The constricted portion was reduced to 1/8-inch for the other materials, and for these the length of the narrowed section was approximately twelve times the width. The sectional dimensions were measured with an accuracy within 1%.

The method of loading is illustrated in Figure 9. The tensions produced in the specimen by the weight of the lever arm and the various loads on the lever arm were determined by experiment, and friction determinations were made for the various loads. It was found to be sufficiently accurate to calculate tensions from moments allowing for friction. Due to variations in friction, the tension values are not as accurate as the dimension measurements, but exceed greatly the accuracy obtainable in the measurements of the crystal deformations.

The incident beam makes a definite angle with the plane of the table of the diffraction machine which was approximately horizontal, and the metal specimen was perpendicular to the plane of that table. These facts, shown in the figure, give the angle Φ that the perpendicular to the planes makes with the direction of the applied tension as $(\Theta\text{-}5)°$, where Θ is the angle of incidence and is measured directly on the films and 5° is the angle that the incident ray makes with the table of the diffraction machine, which angle was determined by a series of careful measurements with sufficient accuracy for the purposes of this problem. The component of stress in the direction of "d" is the stress that tends to separate the planes and is responsible for the strains recorded as variations in "d." The value of this component is given by the expression:

total stress x $\cos(\Theta\text{-}5)°$

for each plane system.

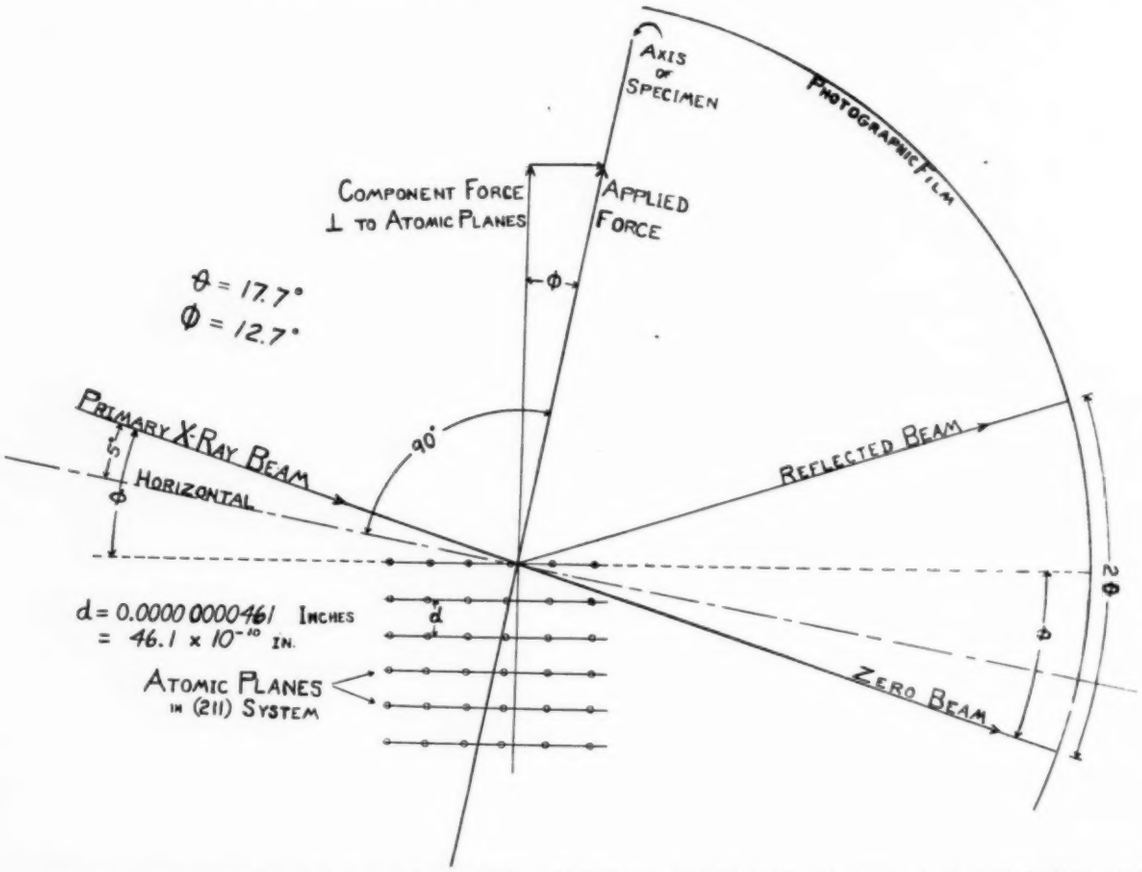


Fig. 12. Forces applied to the crystals. Showing orientation of applied force to one set of crystal planes and method of construction for determining the force normal to the planes. The component parallel to the planes tends to cause "slip."

In order to get the tension on the crystal it is assumed that there is a uniform distribution of stress in the material and that the stress on the crystal is the stress on the material. To get the stress in the direction of the "d" values, the variations in which are measured, the stress on the material was divided into components perpendicular to and parallel to the direction of "d." How this may be done is illustrated in Figure 12. It is seen that the particular plane system whose spacing is being measured makes a definite angle with the incident beam which is measured by ½ the arc subtended on the film by the zero line and the diffracted image from that plane system. The components of the total stress parallel to the planes tend to cause the planes to slip over each other.

The stresses for the individual plane systems were plotted against percentages of total changes in "d" in the curves of figures.

Measurement of Films

The magnitude of the relative displacement of the lines from the stressed with reference to the adjacent ones from the unstressed specimens was very small, varying from .001″ up to about .020″, the latter value occuring only in few cases. The average displacement was under .010″. It was possible to duplicate settings to about .003″, but

the lines were not quite straight and in most cases they were, like all X-ray spectrum lines, more or less diffuse, and besides there is usually a question as to what density in the line corresponds to the line edge. For these reasons the accuracy with which settings may be duplicated does not measure the accuracy of the measurements. In order to overcome these difficulties the lines were measured at more than one point and for each point usually the average of 10 settings was recorded as the reading. After reading in this way the films were put away for a period of more than a month and measured again. Each set of readings was consistent, but the two sets differed. Measurements to determine film shrinkage indicated that the differences could not be ascribed to this cause. It was assumed that the differences were due to a different estimation of the density in the line that marked the edge of the line. For this reason these differences were taken to measure the probable accuracy of the settings and to give the widest latitude for error the accuracy of the settings was recorded as the average deviation from the mean of the two sets of readings. It is probable that these averages are not in error by the amounts indicated. Another possible source of error might come from the fact that the two specimens in the holder might not have been exactly in the axis of the cassette, the one under load was held in alignment by the tension, but the other one could have been out of alignment by as much as .001″. In addition there was a possibility that the horizontal axis of the flat X-ray beam was not always parallel to the table of the diffraction machine. Either of the above possibilities might have produced some shift in one set of lines with reference to the other. Errors from such cause would be small and would not have appreciable effect in the measurements on the blued stock. For the other materials they were compensated. This was done by making check runs at the lowest load that would keep the specimens taut for each experimental set-up. After the check run, the load was stepped up to the desired value and an exposure made without disturbing the apparatus. The line shifts found with the low loads were subtracted from those found with the higher loads and this difference plotted, so that in these cases the curves show the strain values above those for the lowest loads.

(Part II of this article will be published in the November-December issue of this Journal.)

Who's Who In This Issue

REAR ADMIRAL WM. A. MOFFETT, U. S. N., who contributes a paper on "Naval Aviation" is Chief of the Bureau of Aeronautics of the Navy Department. Admiral Moffett has a long and noteworthy record of service. His interest and untiring zeal for naval aeronautics have merited the high place he holds in our National defense councils.

Maj. C. G. Mettler, Ord. Dept., U. S. A., who writes on "Antiaircraft," is Assistant to the Chief of Technical Staff, Office of the Chief of Ordnance, and is well known to our readers.

Maj. G. M. Barnes, Ord. Dept., U. S. A., author of the paper "Aircraft Ordnance — Yesterday, Today and Tomorrow," is in charge of antiaircraft development in the Artillery Division of the Ordnance Office and describes some of the latest tests and developments that have been carried out under his supervision.

Wm. C. L. Eglin, Sc.D., a pioneer in the electric power industry, is author of the paper on "The Franklin Institute," and is President of that organization. Dr. Eglin is identified with many public-spirited activities and has done much to enhance the already noteworthy record of the Institute.

The very enlightening article on "The National Machine Tool Builders' Association" is from the pen of August H. Tuechter, President of the Cincinnati Bickford Tool Company, Cincinnati, Ohio, and former President of the National Machine Tool Builders' Association.

Godfrey L. Cabot, President of the National Aeronautic Association, describes in a brief paper some of the principal accomplishments of that organiaztion during its brief existence. Mr. Cabot has taken a great personal interest in the N. A. A., and to him can be attributed a great part of its growth and influence.

We begin in this issue the publication of a most interesting report on "The Behavior Under Stress of the Iron Crystals in Steel," by H. H. Lester and R. H. Aborn. Mr. Lester is research physicist at the Watertown Arsenal Laboratory and is well known as a pioneer in the radiography of metals. Mr. Aborn is research assistant at Watertown where his work is meriting considerable praise.

Following the announcement in these pages in the May-June issue that the Army Ordnance Association will award the ordnance trophy to tne winner of the President's Match of the National Matches, Maj. Glenn P. Wilhelm, Ord. Dept., U. S. A., Chief of the Infantry and Aircraft Armament Division, Manufacturing Service, Office of the Chief of Ordnance, describes in his paper the "Ordnance Trophy," the Springfield Special, which will be awarded to the winner of the President's Match this yeai

Lt. Col. Fred L. M. Masury, Ord. Res., who describes in an interesting article the activities of the Ordnance Section of the Ninth Corps Area Staff Training Camp, was for several years head of the Masurite Explosive Company at Masury, Ohio. During the World War he served as head of the Powder and Explosives Section, Inspection Division of the Philadelphia Ordnance District and as Commanding Officer of the U. S. Ammonium Nitrate Plant at Perryville, Md.

Col. Edward F. Miller, Ord. Res., Professor of Mechanical Engineering, Massachusetts Institute of Technology, contributes a very learned discussion of "Relation Between Pressure, Volume, and Temperature of Gaseous Air Under High Compressions." Colonel Miller was recentiy elected head of the newly formed Boston Post of the Army Ordnance Association.

Messrs. C. A. Taylor and E. P. Buxton, co-authors of "Silver Fulminate: An Initiator of Detonation," are research chemists on the staff of the Pittsburgh Experiment Station, Bureau of Mines.

Editorials

Seventh Annual Meeting

WAR DEPARTMENT

WASHINGTON

August 21, 1925.

MR. BENEDICT CROWELL, *President,*
Army Ordnance Association,
806 *Mills Building,*
Washington, D. C.

MY DEAR MR. CROWELL:

In reply to letter of the Secretary of the Army Ordnance Association of the 21st instant, you are advised that the War Department is pleased to grant authority for the Army Ordnance Association to hold its Seventh Annual Meeting at the Aberdeen Proving Ground on October 2, 1925.

The Annual Meeting of the Army Ordnance Association is considered an important phase of the War Department's industrial planning and I assure you that any coöperative action taken by the several branches of the War Department and the Commanding General of the Third Corps Area has my full approval.

Sincerely yours,

Dwight F. Davis

ACTING SECRETARY OF WAR.

AS announced elsewhere in this issue, the Seventh Annual Meeting of the Army Ordnance Association will be held at the Aberdeen Proving Ground, Friday, October 2, 1925. The National Aeronautic Association, the Franklin Institute of Philadelphia, and the National Machine Tool Builders' Association have been invited.

The indications are that this, the Seventh Annual Meeting, will be most noteworthy. We have never had a more representative body of participating guests including, as they do, activities and organizations which have a very close relationship to ordnance and the national defense. Ancient in everything except spirit and the will to do, the Franklin Institute of Philadelphia is one of the epoch-making organizations of our country. Only last year it celebrated the centenary of its foundation when its benefactions to America and mankind generally were heralded throughout the land. Few of our public-spirited organizations have had a more brilliant or useful career. The development of mechanical arts has always been a prime consideration of the Institute so that its relation with ordnance and munitions development is most striking. We therefore feel that attendance of the Franklin Institute at our meeting is a helpful and auspicious indication that this society of long standing is mindful of the application of mechanical arts to adequate national defense.

Participation in our meeting by the National Aeronautic Association is likewise an auspicious event. Pledged to the development of aeronautics and to the maintenance of the country's supremacy in the air, the National Aeronautic Association includes in its membership a body of men unexcelled for public spirit and understanding of aeronautic problems and their relation to the national defense.

It is trite to say that the relation between aeronautics and ordnance is vital. The rapid evolution of the airplane and its potential use as a weapon of defense have brought ordnance and aeronautics face to face with the problem of developing jointly the best means of affecting the mission of both. It is no vain boast to say that as the airplane has developed so also have the weapons with which it is armed. It is a source of pride to the Ordnance Department that within the short span of eight years it has developed bombs and bomb sights together with aircraft machine guns and other accessories that are concrete evidence of coöperation between the two branches of our national defense. We are confident that the National Aeronautic Association will find our meeting of tremendous interest in view of the fact that the air features will be emphasized and opportunities to view ordnance developments in relation to the airplane will be plentiful.

The National Machine Tool Builders' Association, which will also participate in our meeting, is inseparably related to ordnance. The World War left no doubt that the machine tool industry is one of the key organizations upon which the supply of munitions depends. There were few problems of those trying days which outweighed in urgency the many complicated questions which arose over jigs, tools, fixtures and gages. The presence of this organization at our meeting will doubtless be a benefit to its members and will be further indication that the peace-time development of munitions is worthy of thought in order that our war-time needs may be adequately handled.

Our annual meetings in the past have been the rallying point of the year for all those interested in this phase of national defense. As the years pass members are more anxious to attend so that, based on experience, there is every indication that the Seventh Annual Meeting will bring out a large attendance of our own members. This, of course, is as it should be. We urge every member who can possibly attend to do so and we assure a day replete with interesting ordnance demonstrations and good fellowship. The program, copies of which are being sent to all members and guests, gives only a general idea of the interesting day that has been arranged.

Show your approval of the Association's past record and your faith in its future by your personal attendance at the meeting.

Today's Targets

THE ultimate destination of ordnance is the target and there are many angles from which targets can be studied. Without consulting the dictionary we can use the word "target" as meaning something we shoot at, and therefore to consider today's targets we must glance at today's shooting.

Because of the world importance of France and the strength of her army, the ordnance observer finds his attention demanded by the French operations in the Riff, that troubled zone in northeast Morocco. There we find the nature of the target as viewed from the French side of the line of contact elusive and unstable and more easily described by what it is not than by what it is. There are none of the massive mechanisms and organizations which we accept as necessary to sustain modern civilization. Where are the highly developed transport systems including docks, warehouses, shops, railroads, power plants, and communication systems? Not in the Riff to be sure, and therefore the class of targets popularly considered as the easy prey of heavy guns and bombing airplanes is eliminated. There are not even extensive water systems or cities or towns of consequence. Agriculture is the predominant industry, and it is a difficult industry to destroy. Even the armed forces opposing the French are not to be found in masses of sufficient size to warrant the use of large caliber artillery. Nor have they organized their positions with field works of earth, wire and concrete requiring demolition by shell or bomb. Operation in friendly territory eliminates the necessity for heavy cumbersome supply columns so that in the final analysis we find the individual soldier, the arms and ammuntion carried on his person, and possibly his horse, playing the role of target for the French in the current operations.

None can doubt that the French will use the ordnance best suited to hit the target once a real offensive is launched and to many the prominence of the rifle and machine gun may at the outset appear puzzling, but if the target is kept in mind the logic of their use in this situation is apparent.

Leaving the problem of the Riff to the French, we find in our own Army a very different array of targets engaging our attention. In all cases our targets are being used in peaceful tests of the efficiency of our ordnance and the skill of our armed forces. The Coast Artillery are concentrating their efforts against little flag-topped pyramids far out at sea in the trial of the heavy mobile and fixed armament, the antiaircraft regiments are puncturing a sleeve towed by an airplane with their cannon and machine-gun fire, the Air Service is bombing the outlines of battleships and field works and machine gunning outlined troops in mass formation or column of march, while the Field Artillery, Cavalry and Infantry fire from sunrise to sunset to score hits on a variety of silhouettes representing men, animals and batteries which hide themselves in the camouflage of nature, appear and disappear, stand still and move, in fact, do everything except talk and shoot back. All in the interest of national preparedness!

Antiaircraft

A GREAT deal has been said of late about antiaircraft and much credit has been given by proponents of the airplane to the supremacy of the plane over antiaircraft weapons. It is not our purpose to enter into any controversy regarding the relative merits of either arm. Wisdom suggests the midde ground as the better stand for those whose paramount interest is the national defense.

The airplane has not made obsolete the antiaircraft battery nor have ground weapons nullified the effects of aircraft. In this issue papers are presented which give in detail the present standing of ordnance in its relation to aircraft. Let us hope that they will be widely read and that their publication will contribute to a better understanding of this most important question.

There is no more fairness in comparing the effectiveness of an absolete gun against an ultra modern plane than there is in racing a primitive automobile against the mechanical wonders of today. The marvel is that many of those who should reserve judgment have not done so and that erroneous conclusions have been released to the public.

A reasonable and balanced national defense program requires an adequate provision of both aircraft and antiaircraft, and the ordnance of both services must be the best obtainable.

The Ordnance Trophy

AS previously anounced in these pages, the Army Ordnance Association will award to the winner of the President's Match of the National Matches an ordnance trophy, this year in the form of a "Springfield Special," a sport type of the caliber .30 rifle especially selected for accuracy and beauty. The weapon which will constitute the award this year is fully described by Maj. Glenn P. Wilhelm, Ord. Dept., U. S. A., in this issue.

The development of small arms and promotion of their use are essential to the national defense, and the Army Ordnance Association considers it a privilege to add its small measure of encouragement in this important field.

Time Factor in Ordnance Manufacture

THE time factor in the production of ordnance deserves special consideration both in peace and war, and the 14-inch gun and railway mount which is completing its tests at the Aberdeen Proving Ground serves as an example of its importance. The design of this gun and carriage was practically completed in 1920, and an excellent account of the matériel by Maj. G. M. Barnes, Ord. Dept., U. S. A., published in ARMY ORDNANCE, Vol. I, No. 3, November-December, 1920, page 101.

The gun itself is a product of the Watervliet Arsenal, weighs 250,000 pounds, has a length of 60 feet and uses a propelling charge of 460 pounds of smokeless powder to fire an explosive projectile weighing 1,560 pounds a distance of 25 miles. The carriage, built at the Watertown Arsenal, provides for a 360-degree traverse and elevations from minus 7 degrees to plus 50 degrees.

The transcontinental service test of this unit, culminating with firings on the Pacific Coast, will furnish data for future designs and improvements. Just what portion of the time consumed in the manufacture and test of this gigantic piece of ordnance could be saved under the pressure of war demands is problematical, but however great the demand and however available designs, funds, and facilities, there will always be the necessity of dealing with the time factor in the production of ordnance, and a plan of manufacture which properly controls the time factor is the principal objective of industrial planning.

Reserve Corps Notes

Items of Interest to Members of the Ordnance Department Reserve

Edited by Major John A. Brooks, Jr., Military Personnel Section, Office of the Chief of Ordnance

Ordnance Reserve Training Camps

DURING the month of August, two training camps for Ordnance Reserve Officers were held with most encouraging results. At the Aberdeen Proving Ground from August 2nd to 16th one of the largest camps in the history of Ordnance Reserve training was held. A story of the camp appears elsewhere in this issue. On August 16th a camp was opened at Rock Island Arsenal for Ordnance Reserve Officers, some 45 Reservists having been ordered there for a fifteen-day training period. We hope to publish a story in a subsequent issue of this journal giving a detailed account of the Rock Island Camp. The following officers of the Branch Assignment Group were ordered to duty at Rock Island Arsenal for the period August 16th to 30th:

Maj. Lindsley M. Brown, Sr., Ord. Res.,
3721 Travis Ave., Fort Worth, Tex.

Maj. Louis A. Daerr, Ord. Res.,
216 N. 18th St., Quincy, Ill.

Maj. Albert W. Draves, Ord. Res.,
1284 Stowell Ave., Shorewood, Milwaukee, Wis.

Maj. James B. Fitzgerald, Ord. Res.,
Hollywood, Ill.

Maj. Alexander K. Hamilton, Ord. Res.,
5413 Cornell Ave., Chicago, Ill.

Maj. Hugh B. LaRue, Ord. Res.,
331 Forest Road, Davenport, Iowa.

Maj. Eric H. Lichtenberg, Ord. Res.,
Koehring Co., Milwaukee, Wis.

Maj. Charles F. Queisser, Ord. Res.,
3232 Warrington Road, Cleveland, Ohio.

Maj. Elmer E. Snare, Ord. Res.,
8021 Constance Ave., Chicago, Ill.

Maj. Herman L. Wittstein, Ord. Res.,
81 Alston Ave., New Haven, Conn.

Capt. Walter H. Damon, Ord. Res.,
6739 Cornell Ave., Chicago, Ill.

Capt. Charles M. Haines, Ord. Res.,
2822 Lee St., Greenville, Tex.

Capt. Herbert B. McKahin, Ord. Res.,
923 16th St., Moline, Ill.

Capt. Camille A. Meyer, Ord. Res.,
118 West 16th St., Davenport, Iowa.

Capt. Frank A. Mickle, Ord. Res.,
1053 Olivia Ave., Ann Arbor, Mich.

Capt. Thomas E. Moon, Ord. Res.,
250 So. Madison Ave., Congress Park, Ill.

Capt. Fred B. Zimmerman, Ord. Res.,
5488 University Ave., Chicago, Ill.

1st Lieut. Hollis S. Beatty, Ord. Res.,
810 W. North Ave., Pittsburgh, Pa.

1st Lieut. Holger H. Bing, Ord. Res.,
1402 Washington Ave., Racine, Wis.

1st Lieut. Levi C. Eddy, Ord. Res.,
645 Cass St., Mailwaukee, Wis.

1st Lieut. John D. Frost, Ord. Res.,
1720½ Lincoln Court, Rock Island, Ill.

1st Lieut. Roy S. Haggard, Ord. Res.,
Wolfeboro, N. H.

1st Lieut. Carl E. Heimbrodt, Ord. Res.,
185 Lawn Ave., Western Springs, Ill.

1st Lieut. William Kendall, Ord. Res.,
Rock Island Arsenal, Rock Island, Ill.

1st Lieut. Robert E. N. Marks, Ord. Res.,
1509 Jonquill Terrace, Chicago, Ill.

1st Lieut. George A. Moshchansky, Ord. Res.,
719 Hawthorne Ave., So. Milwaukee, Wis.

2nd Lieut. Russell R. Byer, Ord. Res.,
Willshire, Ohio.

2nd Lieut. Stuart O. Fiedler, Ord. Res.,
1333 Drake St., Madison, Wis.

2nd Lieut. Gordon C. Fowler, Ord. Res.,
105 So. Austin Blvd., Chicago, Ill.

2nd Lieut. Whitney B. Hobbs, Ord. Res.,
107 Gale Ave., River Forest, Ill.

2nd Lieut. Joseph A. Peterson, Ord. Res.,
Box 120, College Station, Tex.

2nd Lieut. Harry T. Prothero, Ord. Res.,
1203 Brown St., Davenport, Iowa.

2nd Lieut. Crandall Z. Rosecrans, Ord. Res.,
903 So. 4th St., Champaign, Ill.

2nd Lieut. Floyd S. Sutherland, Ord. Res.,
518 Chestnut St., Waukegan, Ill.

The following officers of the Territorial Assignment Group were also ordered to Rock Island:

Major Franz S. Blue, Ord. Res.,
202 Bank of Commerce Building, Toledo, Ohio.

Major James D. Polley, Ord. Res.,
504 Guardian Building, Cleveland, Ohio.

Capt. Albert W. Heinrich, Ord. Res.,
1428 Elmwood Ave., Lakewood, Ohio.

Capt. Camden Hogg, Ord. Res.,
Kokomo, Ind.

Capt. Cecil E. Watts, Ord. Res.,
132 9th Ave., So. Charleston, W. Va.

1st Lieut. Harry T. Chapin, Ord. Res.,
20 Rhodes Ave., So. Charleston, W. Va.

1st Lieut. LeRoy Hedges, Ord. Res.,
503 W. Miller St., Bluffton, Ind.

1st Lieut. Lorin D. McCleary, Ord. Res.,
2105 Ashland Ave., Indianapolis, Ind.
2nd Lieut. Noah O. Bradley, Ord. Res.,
1243 E. Market St., Akron, Ohio.
2nd Lieut. Edward F. Seiller, Ord. Res.,
2214 W. Jefferson St., Louisville, Ky.
2nd Lieut. Fred M. Thrun, Ord. Res.,
125 E. College Ave., Springfield, Ohio.

Recently Assigned Ordnance Reserve Officers

THE following reserve officers have recently been assigned as indicated:

Maj. Victor F. Emerson, Ord. Res., Manufacturing Service, Philadelphia District Ordnance Office, Philadelphia, Pa.
Maj. Henry Huss, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.
Maj. Thomas W. Ruth, Ord. Res., Territorial Assignment Group.
Capt. Miles C. Bland, Ord. Res., Manufacturing Service, Philadelphia District Ordnance Office, Philadelphia, Pa.
Capt. Samuel J. Carr, Ord. Res., Territorial Assignment Group.
Capt. John W. Cory, Jr., Ord. Res., Territorial Assignment Group.
Capt. William F. Costello, Ord. Res., Manufacturing Service, Bridgeport District Ordnance Office, Springfield Armory, Springfield, Mass.
Capt. David L. Woodberry, Ord. Res., Manufacturing Service, Ammunition Division, Washington, D. C.
1st Lieut. Charles L. Allen, Ord. Res., Manufacturing Service, Ammunition Division, Washington, D. C.
1st Lieut. Floyd N. Calhoon, Ord. Res., Technical Staff, Aberdeen Proving Ground, Md.
1st Lieut. John D. Frost, Ord. Res., Manufacturing Service, Rock Island Arsenal, Rock Island, Ill.
1st Lieut. George R. Hilby, Ord. Res., Territorial Assignment Group.
1st Lieut. William Kendall, Ord. Res., Manufacturing Service, Rock Island Arsenal, Rock Island, Ill.
1st Lieut. Richard C. W. Mugler, Ord. Res., Manufacturing Service, New York District Ordnance Office, New York, N. Y.
1st Lieut. Tillman T. Pierce, Ord. Res., General Office, Ordnance Specialists' School, Raritan Arsenal, Metuchen, N. J.
1st Lieut. George B. Roth, Ord. Res., Manufacturing Service, Buffalo District Ordnance Office, Watervliet Arsenal, Watervliet, N. Y.
1st Lieut. Henry A. Wolsdorf, Ord. Res., Manufacturing Service, Artillery Division, Washington, D. C.
2nd Lieut. Nicholas A. Athanason, Ord. Res., Territorial Assignment Group.
2nd Lieut. Leonard E. Bates, Ord. Res., Territorial Assignment Group.
2nd Lieut. Harold H. Belcher, Ord. Res., Territorial Assignment Group.
2nd Lieut. William Bisch, Ord. Res., Territorial Assignment Group.
2nd Lieut. Charles C. Breithaupt, Ord. Res., Territorial Assignment Group.
2nd Lieut. Howard W. Burden, Ord. Res., Territorial Assignment Group.
2nd Lieut. George C. Caine, Ord. Res., Territorial Assignment Group.
2nd Lieut. Charles A. Carpenter, Ord. Res., Technical Staff, Aberdeen Proving Ground, Md.
2nd Lieut. Cader W. Cheatham, Ord. Res., Territorial Assignment Group.
2nd Lieut. Hal B. Coats, Ord. Res., Territorial Assignment Group.
2nd Lieut. Warren G. Coryell, Ord. Res., Manufacturing Service, Cleveland District Ordnance Office, Cleveland, Ohio.
2nd Lieut. Raymond A. Dewey, Ord. Res., Manufacturing Service, Watervliet Arsenal, Watervliet, N. Y.
2nd Lieut. Norman E. Dietz, Ord. Res., Territorial Assignment Group.
2nd Lieut. Myron E. Doucette, Ord. Res., Manufacturing Service, Boston District Ordnance Office, Boston, Mass.
2nd Lieut. George M. Droge, Ord. Res., Territorial Assignment Group.
2nd Lieut. Albert C. Durham, Ord. Res., Territorial Assignment Group.
2nd Lieut. Edward W. Eager, Jr., Ord. Res., Manufacturing Service, Boston District Ordnance Office, Boston, Mass.
2nd Lieut. Irving M. Flanders, Ord. Res., Territorial Assignment Group.
2nd Lieut. George C. Forester, Ord. Res., Territorial Assignment Group.
2nd Lieut. William R. Gilkeson, Ord. Res., Territorial Assignment Group.
2nd Lieut. Peter G. Hanigan, Ord. Res., Territorial Assignment Group.
2nd Lieut. Ralph R. Hardigree, Ord. Res., Territorial Assignment Group.
2nd Lieut. LeRoy Horton, Jr., Ord. Res., Territorial Assignment Group.
2nd Lieut. James H. Howard, Ord. Res., Manufacturing Service, Boston District Ordnance Office, Boston, Mass.
2nd Lieut. Frederick M. Hull, Ord. Res., Territorial Assignment Group.
2nd Lieut. David B. Hyer, Jr., Ord. Res., Territorial Assignment Group.
2nd Lieut. Leon H. Jagrowski, Ord. Res., Territorial Assignment Group.
2nd Lieut. Owen V. Keller, Ord. Res., Manufacturing Service, Detroit District Ordnance Office, Detroit, Mich.
2nd Lieut. George F. Kennedy, Ord. Res., Territorial Assignment Group.
2nd Lieut. Jacob W. Lang, Jr., Ord. Res., Territorial Assignment Group.
2nd Lieut. John K. Laycock, Jr., Ord. Res., Territorial Assignment Group.
2nd Lieut. Charles A. LeBey, Ord. Res., Territorial Assignment Group.
2nd Lieut. Theodore W. Legatski, Ord. Res., Territorial Assignment Group.
2nd Lieut. James M. Lynch, Ord. Res., Territorial Assignment Group.
2nd Lieut. Raymond A. Martin, Ord. Res., Territorial Assignment Group.
2nd Lieut. Joseph G. Moffett, Ord. Res., Manufacturing Service, Bridgeport District Ordnance Office, Springfield Armory, Springfield, Mass.

2nd Lieut. Charles T. Morrow, Ord. Res., Territorial Assignment Group.
2nd Lieut. Thomas G. Murdock, Ord. Res., Manufacturing Service, Birmingham District Ordnance Office, Birmingham, Ala.
2nd Lieut. Harry S. Nelson, Ord. Res., Manufacturing Service, Bridgeport District Ordnance Office, Springfield Armory, Springfield, Mass.
2nd Lieut. George Oetinger, Jr., Ord. Res., Manufacturing Service, Boston District Ordnance Office, Boston, Mass.
2nd Lieut. Henry H. Passolt, Ord. Res., Territorial Assignment Group.
2nd Lieut. Harold C. Porter, Ord. Res., Territorial Assignment Group.
2nd Lieut. Howard M. Preston, Ord. Res., Territorial Assignment Group.
2nd Lieut. Clyde C. Sowards, Ord. Res., Territorial Assignment Group.
2nd Lieut. Edwin H. Strunk, Ord. Res., Manufacturing Service, Watervliet Arsenal, Watervliet, N. Y.
2nd Lieut. Louis R. Stutz, Ord. Res., Territorial Assignment Group.
2nd Lieut. Norris W. Upson, Ord. Res., Territorial Assignment Group.
2nd Lieut. Frederick A. Weihe, Jr., Ord. Res., Territorial Assignment Group.
2nd Lieut. Ralph E. West, Ord. Res., Territorial Assignment Group.
2nd Lieut. Carl B. Whyte, Ord. Res., Territorial Assignment Group.
2nd Lieut. Ralph A. Wike, Ord. Res., Territorial Assignment Group.
2nd Lieut. Louis M. Wolford, Ord. Res., Manufacturing Service, Pittsburgh District Ordnance Office, Pittsburgh, Pa.

Recently Commissioned Ordnance Reserve Officers

THE following have accepted reserve commissions since the last issue of ARMY ORDNANCE:

Maj. Thomas W. Ruth, Ord. Res.,
227 N. Tyron St., Charlotte, N. C.
Capt. Samuel J. Carr, Ord. Res.,
Claremore, Okla.
Capt. Hugh E. Coleman, Ord. Res.,
900 Drexel Ave., San Antonio, Tex.
Capt. John W. Cory, Jr., Ord. Res.,
1281 No. Main St., Spencer, Iowa.
Capt. William F. Costello, Ord. Res.,
32 Garden St., New Britain, Conn.
Capt. Harry J. McIntyre, Ord. Res.,
7704 1st Ave., N. E., Seatle, Wash.
Capt. George A. Sherron, Ord. Res.,
6818 N. 18th St., Philadelphia, Pa.
Capt. David L. Woodberry, Ord. Res.,
Edgewood Arsenal, Md.
1st Lieut. Charles L. Allen, Ord. Res.,
2222 W. 17th St., Wilmington, Del.
1st Lieut. Floyd N. Calhoon, Ord. Res.,
1432 Washtenaw Ave., Ann Arbor, Mich.
1st Lieut. John D. Frost, Ord. Res.,
1720½ Lincoln Court, Rock Island, Ill.
1st Lieut. Marcel E. Juilly, Ord., Res.,
Lomita Park, Colma, Calif.
1st Lieut. William Kendall, Ord. Res.,
Rock Island Arsenal, Rock Island, Ill.
1st Lieut. Kenneth S. Keyes, Ord. Res.,
50 Avery Drive, Atlanta, Ga.
1st Lieut. Richard C. W. Mugler, Ord. Res.,
576 East 135th St., New York, N. Y.
1st Lieut. Tillman T. Pierce, Ord. Res.,
Nitro, W. Va.
1st Lieut. Henry A. Wolsdorf, Ord. Res.,
care Robert College, Constantinople, Turkey.
2nd Lieut. James H. Aiken, Ord. Res.,
11 Maple St., Norwalk, Conn.
2nd Lieut. Erling A. Arentz, Ord. Res.,
1342 Early Ave., Chicago, Ill.
2nd Lieut. Willard C. Asbury, Ord. Res.,
156 Huntington Ave., Boston, Mass.
2nd Lieut. Robert C. Ashworth, Jr., Ord. Res.,
Highland Ave., Tiverton, R. I.
2nd Lieut. Nicholas A. Athanason, Ord. Res.,
Westinghouse Club, Wilkinsburg, Pa.
2nd Lieut. William B. Bader, Ord. Res.,
386 Woodbridge Ave., Buffalo, N. Y.
2nd Lieut. Paul L. Bartow, Ord. Res.,
875 5th St., North, St. Petersburg, Fla.
2nd Lieut. Leonard E. Bates, Ord. Res.,
601 Stephenson St., Wayeross, Ga.
2nd Lieut. Harold H. Belcher, Ord. Res.,
Proctor, Vt.
2nd Lieut. Levi T. Bellah, Ord. Res.,
Stockbridge, Ga.
2nd Lieut. Harold Bishko, Ord. Res.,
1824 E. Genesee St., Syracuse, N. Y.
2nd Lieut. Thomas D. Boyd, Ord. Res.,
501 So. 4th St., Hamilton, Ohio.
2nd Lieut. Charles C. Brithaupt, Ord. Res.,
815 Myrtle Ave., Natchez, Miss.
2nd Lieut. George C. Caine, Ord. Res.,
131 E. 5th Ave., Conshohocken, Pa.
2nd Lieut. Charles A. Carpenter, Ord. Res.,
24 Main St., Whitehall, N. Y.
2nd Lieut. Benjamin E. Chandler, Ord. Res.,
1203 Drayton St., Newberry, S. C.
2nd Lieut. Cader W. Cheatham, Ord. Res.,
212 Washington Ave., Macon, Ga.
2nd Lieut. Hal B. Coats, Ord. Res.,
1336 Coplin Ave., Detroit, Mich.
2nd Lieut. Ralph L. Coryell, Ord. Res.,
1312 16th St., Detroit, Mich.
2nd Lieut. George M. Ehlers, Ord. Res.,
515 Garfield Ave., Milwaukee, Wis.
2nd Lieut. Irving M. Flanders, Ord. Res.,
90 Marthon St., Arlington, Mass.
2nd Lieut. George C. Forester, Ord. Res.,
Cairo, Ga.
2nd Lieut. Walter E. Frielman, Ord. Res.,
2519 Vine St., Cincinnati, Ohio.
2nd Lieut. Rudolph A. Froehlig, Ord. Res.,
779 6th St., Milwaukee, Wis.
2nd Lieut. George H. Fuller, Ord. Res.,
226 Washington St., Woburn, Mass.
2nd Lieut. Louis E. Gates, Ord. Res.,
Bradenton, Fla.

2nd Lieut. Charles E. Geisler, Ord. Res.,
16 Corinsh St., Lawrence, Mass.
2nd Lieut. Bruno T. Gialdini, Ord. Res.,
70 Ehrman Ave., Cincinnati, Ohio.
2nd Lieut. William R. Gilkeson, Ord. Res.,
Summerville, Ga.
2nd Lieut. Walter B. Greeves, Ord. Res.,
1032 McFadden Ave., Beaumont, Tex.
2nd Lieut. Leon J. Griffey, Ord. Res.,
826 Prospect Ave., Janesville, Wis.
2nd Lieut. Ralph R. Hardigree, Ord. Res.,
Winder, Ga.
2nd Lieut. Thomas A. Hayes, Ord. Res.,
109 Queensberry St., Boston, Mass.
2nd Lieut. Walter H. Hickey, Ord. Res.,
49 Julian St., Dorchester, Mass.
2nd Lieut. Spencer G. Hilliard, Ord. Res.,
3400 Wells St., Milwaukee, Wis.
2nd Lieut. LeRoy Horton, Jr., Ord. Res.,
404 Fayette St., Cumberland, Md.
2nd Lieut. Frederick M. Hull, Ord. Res.,
Rockingham, N. C.
2nd Lieut. David B. Hyer, Jr., Ord. Res.,
133 Ashley Ave., Charleston, S. C.
2nd Lieut. Stephen C. Jones, Jr., Ord. Res.,
Jeffersonville, Ga.
2nd Lieut. Gay P. Keith, Ord. Res.,
Gay, Ga.
2nd Lieut. George F. Kennedy, Ord. Res.,
5510 Cornell Ave., Chicago, Ill.
2nd Lieut. Harold E. Kortman, Ord. Res.,
1085 Lewerenz Ave., Detroit, Mich.
2nd Lieut. Edward H. Lang, Ord. Res.,
547 Bramhall Ave., Jersey City, N. J.
2nd Lieut. Jacob W. Lang, Jr., Ord. Res.,
147 Milk St., Boston, Mass.
2nd Lieut. Antonio A. Lauria, Ord. Res.,
21 Turner St., Brockton, Mass.
2nd Lieut. Charles A. LeBey, Ord. Res.,
32 East 44th St., Savannah, Ga.
2nd Lieut. Theodore W. Legatski, Ord. Res.,
125 East Maple St., Alpena, Mich.
2nd Lieut. Raymond E. Lucey, Ord. Res.,
51 Washington St., Newburyport, Mass.
2nd Lieut. James M. Lynch, Ord. Res.,
449 Monroe Ave., Scranton, Pa.
2nd Lieut. George E. Mason, Ord. Res.,
10 Foster St., Attleboro, Mass.
2nd Lieut. Nevin H. McKay, Ord. Res.,
726 Kensington Ave., Plainfield, N. J.
2nd Lieut. Robert H. Morrison, Ord. Res.,
1928 9th Ave., Greeley, Colo.
2nd Lieut. Charles T. Morrow, Ord. Res.,
Sugar Run, Bradford, Pa.
2nd Lieut. Hamnett P. Munger, Ord. Res.,
67 W. 4th St., Atlanta, Ga.
2nd Lieut. Harold V. Oerting, Ord. Res.,
Box 1206, Pensacola, Fla.
2nd Lt. Joseph P. O'Hern, Ord. Res.,
116 Mississippi Ave., Joliet, Ill.
2nd Lieut. William H. Palm, Ord. Res.,
5329 Chancellor St., Philadelphia, Pa.
2nd Lieut. Henry H. Passolt, Ord. Res.,
511 Wood Ave., Bridgeport, Conn.
2nd Lieut. Harold C. Porter, Ord. Res.,
335 15th St., Elyria, Ohio.
2nd Lieut. William R. Potts, Ord. Res.,
Commerce, Ga.
2nd Lieut. Howard M. Preston, Ord. Res.,
7 East Main St., Battle Creek, Mich.
2nd Lieut. Matthew M. Prewitt, Ord. Res.,
R. F. D. No. 1, Columbus, Miss.
2nd Lieut. Walter J. Rhodes, Jr., Ord. Res.,
91 Otis St., Medford, Mass.
2nd Lieut. William M. Richtmann, Ord. Res.,
1709 Adams St., Madison, Wis.
2nd Lieut. George H. Ross, Ord. Res.,
121 N. Forest Ave., Downers Grove, Ill.
2nd Lieut. John P. Sharkey, Ord. Res.,
624 Prytania Ave., Hamilton, Ohio.
2nd Lieut. Earl W. Shriber, Ord. Res.,
3040½ Dohr St., Berkeley, Calif.
2nd Lieut. Louis Small, Ord. Res.,
108 Sherman St., Passaic, N. J.
2nd Lieut. Harold E. Smith, Ord. Res.,
256 West Rock Ave., New Haven, Conn.
2nd Lieut. Herbert P. Sontag, Ord. Res.,
17 Kendall St., Lawrence, Mass.
2nd Lieut. Clyde C. Sowards, Ord. Res.,
Fort Spring, W. Va.
2nd Lieut. Charles W. Spengler, Ord. Res.,
288 Williams St., Atlanta, Ga.
2nd Lieut. Orville W. Stephens, Ord. Res.,
27 Lincoln Ave., Carbondale, Pa.
2nd Lieut. James M. Stephenson, Ord. Res.,
Covington, Ga.
2nd Lieut. Edwin H. Strunk, Ord. Res.,
107 Lake St., Ithaca, N. Y.
2nd Lieut. Louis R. Stutz, Ord. Res.,
1617 Beverly Rd., Brooklyn, N. Y.
2nd Lieut. Irving M. Symonds, Ord. Res.,
134 Spring St., Brockton, Mass.
2nd Lieut. Frank A. Teeple, Jr., Ord. Res.,
Thunderbolt, Ga.
2nd Lieut. Norris W. Upson, Ord. Res.,
604 South Florida Ave., Lakeland, Fla.
2nd Lieut. Joseph F. Walker, Ord. Res.,
91 Gordon St., Perth Amboy, N. J.
2nd Lieut. Frederick A. Weihe, Jr., Ord. Res.,
4000 Marlboro Pl., N. W., Washington, D. C.
2nd Lieut. Ralph E. West, Ord. Res.,
53 Cleveland St., Orange, N. J.
2nd Lieut. Ralph G. Wheeler, Ord. Res.,
Pepin, Wis.
2nd Lieut. John D. White, Ord. Res.,
Tifton, Ga.
2nd Lieut. Carl B. Whyte, Ord. Res.,
1699 Orange St., Beaumont, Tex.
2nd Lieut. Ralph A. Wike, Ord. Res.,
308 Adams Ave., Endicott, N. Y.
2nd Lieut. Gerald E. Wilcox, Ord. Res.,
Fitzgerald, Ga.
2nd Lieut. Louis M. Wolford, Ord. Res.,
129 Sumner Ave., Vandergrift, Pa.
2nd Lieut. Theodore F. Ziegler, Ord. Res.,
934 E. Pacific St., Appleton, Wis.

Professional Notes

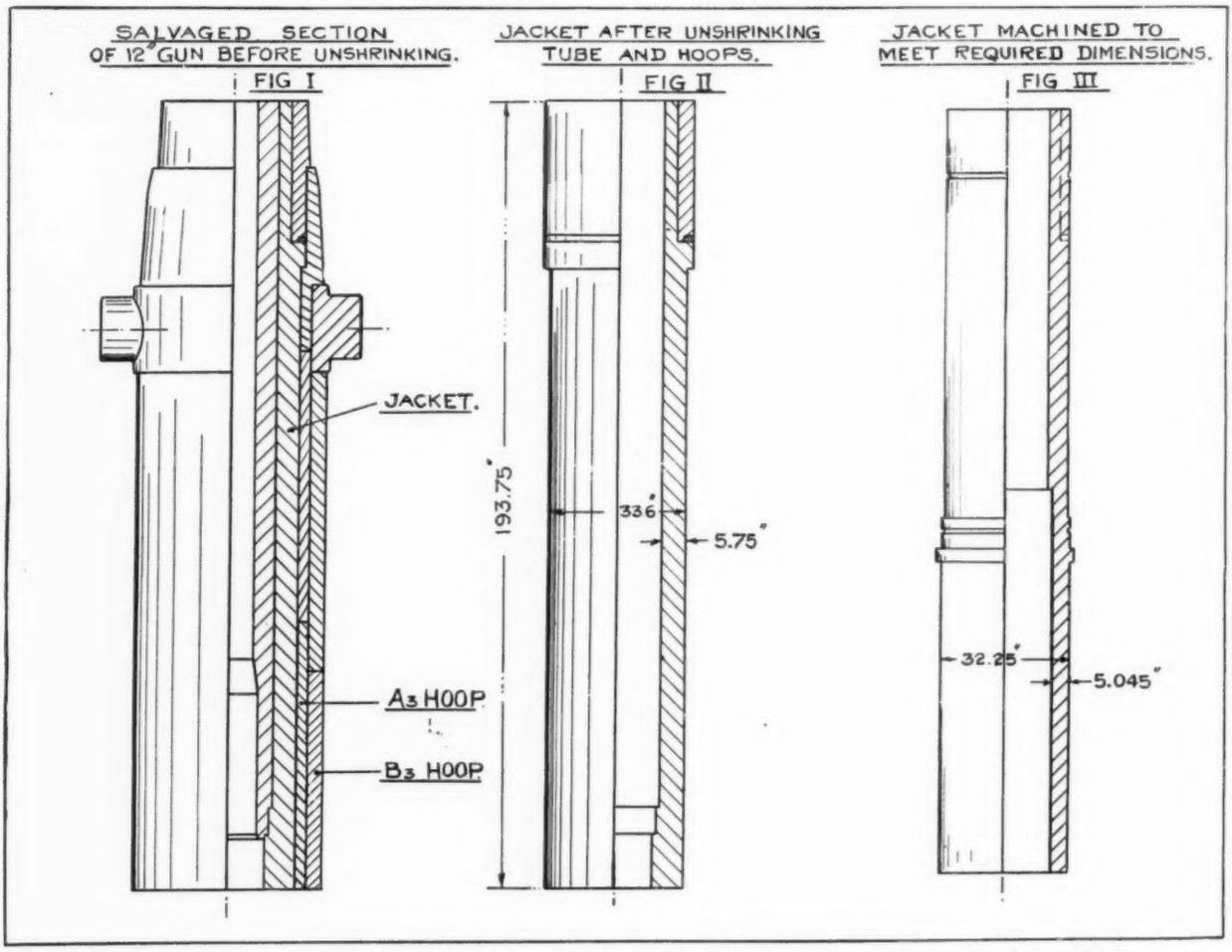
WATERVLIET ARSENAL

Salvaging a 12-Inch Jacket

SOME years ago when the practice of inserting liners in worn guns was in the experimental stage, several of the outer hoops on a large caliber cannon were found to be loose after the liner had been assembled.

It was found that after heating the gun and inserting the liner water had been applied to the exterior of the heated gun for the purpose of contracting it toward the shoulder on the liner. This cooling of these outer cylinders had the effect of contracting them against the heated and expanded inner members so that they had become overstressed and a permanent enlargement had taken place. It was merely a question of the forces causing the hoop to contract being opposed by much greater forces holding the inner members in an expanded condition. The cause of this unfortunate experience has recently been used to advantage in salvaging an inner member from a breech-end section of an obsolete 12-inch gun, model 1895. Briefly what took place is as follows:

The Watertown Arsenal has recently had need for a large forged steel cylinder. The cost of manufacturing such a forging was high, so a search was made for a suitabe substitute in the form of an obsolete gun forging. Such a forging was located at Watervliet Arsenal. This forging was not found loose on the scrap heap, but was in the breech section of a built-up 12-inch gun. To machine off the outer members would be expensive; to un-



Sketch showing location of jacket to be salvaged and dimensions of various members composing built-up gun.

shrink all of the members was not practicable, due to the thickness of the walls. (The walls were so thick that it was doubtful if the ordinary method of refrigerating the inner members would "break the shrinkage" and allow it to be "dropped out.") It was therefore decided to remove the outer members by overstressing them. The accompanying sketch shows the location of the jacket to be salvaged and also the length and thickness of the various members composing this built-up gun.

The section of the 12-inch gun was put into the electric furnace and heated to 1070° F. This took about 24 hours. The gun was then suspended over the shrink pit and the outer surface rapidly cooled by water from five water rings. This was continued for about two and one-half hours, during which time the two lower hoops dropped off, the trunnion hoop alone remaining on the gun. The gun was allowed to cool to shop temperature, and it was noted that the trunnion hoop was free from the jacket at two points, just under the trunnions, which was probably due to the irregular shape of the trunnion hoop. As long as the trunnion hoop was free at two points it was believed that a local application of heat to the section in contact would produce sufficient expansion so that the trunnion hoop would drop off. This proved to be the case, and the trunnion hoop dropped clear of the gun after applying two torches for two and one-half hours.

The section of the gun remaining was again placed in the electric furnace and brought up to approximately 1000° F. The above mentioned outer cooling process was repeated and the three hoops dropped off in one hour and twenty minutes. This left exposed the jacket to be salvaged with the original tube the only other member to be removed.

It was believed that a similar operation, that is, heating the compound cylinder and rapidly cooling the outer member, might successfully separate the jacket from the tube. There was some uncertainty, however, about the success of this method since with only one heated interior cylinder there might result a combination of stretching the outer member and crushing the inner member, without obtaining actual separation or at least sufficient separation to permit them dropping apart. It was therefore decided to use the method of refrigerating the tube, as this method had been successfully employed on many occasions under similar conditions.

The section of the gun was placed in a lathe and the two ends of the tube were machined to receive the lifting hook with water head and the lower water plug. This done, the gun was again placed in the furnace and by the common refrigerating process the jacket was dropped off. The heat used this time was 950° F.

Up to the beginning of this last operation, no machine work had been done on the gun. The expense so far has been mainly for electricity and water. The jacket salvaged was practically to size, as far as interior diameter was concerned, and the cost of turning the exterior surface to finished dimension was not great. The total cost of the work done to supply the desired cylinder was considerably less than the anticipated cost of a new forging with necessary machining.

A few figures are given to show the amount of permanent set produced in some of the members during the above operations.

The original diameter of B^3 Hoop.....46.200 inches,
After removing B^3 Hoop.....46.258 inches,
Permanent enlargement B^3 Hoop.....+ .058 inch.

Original diameter of A^3 Hoop.....39.350 inches,
After removing A^3 Hoop.....39.395 inches,
Permanent enlargement A^3 Hoop..... + .045 inch.

The above figures were measured at a point about 16 inches from the breech end of the salvaged gun section.

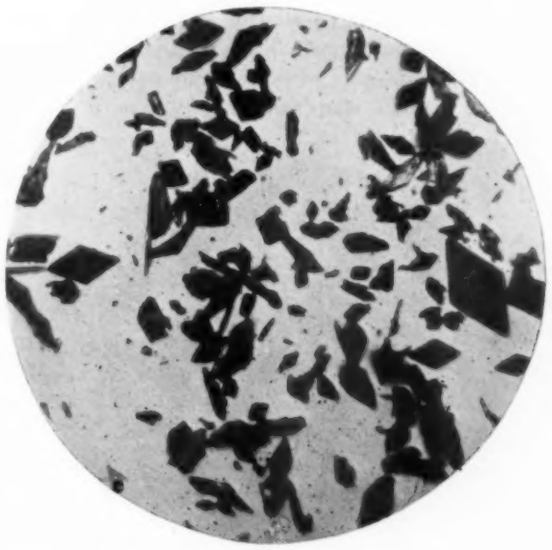
As far as is known at Watervliet Arsenal, this represents the first practical application in disassembling gun members by means of overstressing exterior members. The success with which these operations were carried out will probably make possible salvaging other valuable forgings from obsolete or damaged built-up guns.

A. H. SKINNER,
Capt. Ord. Dept., U. S. A.

PICATINNY ARSENAL

Lead Azide as a Detonating Explosive

MERCURY Fulminate was discovered by Howard, an English chemist, in 1799. Although its explosive properties were recognized shortly after and many attempts made to use it instead of black powder as a propellant, the real purpose for which it is suited was not discovered until 1864, when Alfred Nobel, a Swedish engineer, employed it as a primer or detonator for nitroglycerin and dynamite. From the time of these experiments of Nobel, until the present, mercury fulminate has held sway as a detonating or priming explosive in spite of the discovery and thorough investigation of numerous other violently explosive compounds which at first appeared to be suitable for the purpose. This has been due largely to the fact that most of the compounds pro-



Mercury Fulminate Crystals. x 87.

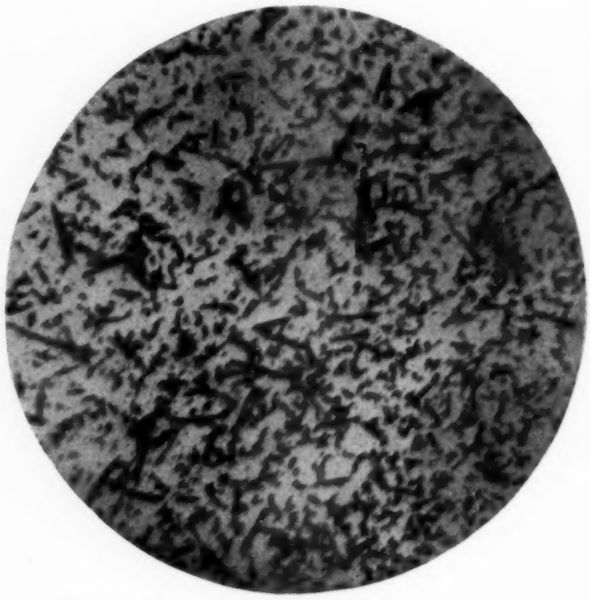
posed as substitutes for fulminate were either so extremely sensitive that they would not withstand the shocks incident to the manufacture and use of the materials, or so low in sensitivity that they could not be brought readily to explosion by the simple means commonly employed.

There is, however, one compound, lead azide, which may be said to have seriously challenged the position held by mercury fulminate. Lead azide is a salt of hydrazoic acid, a compound which was discovered by Curtius in 1890. Although Curtius was acquainted with the explosive properties of the acid and its salts, he made no attempt to develop the compounds as commercial explosives. It was not until 1907 that any of the azides were suggested as a substitute for mercury fulminate. In February of that year F. Hyronimus obtained French patent No. 384792 covering the use of lead azide as a charge for detonators; about two weeks later L. Wohler, a German chemist, patented the heavy metallic salts of hydrazoic acid, including silver and mercury azides, as substitutes for mercury fulminate. (Ref.: German Patent No. 196824.)

Since 1907, lead azide has been investigated extensively in Germany, France, the United States and perhaps elsewhere, until at present the explosive properties of the compound are generally known and the method for its preparation fairly well established. So far as known, however, Germany is the only country that has actually used the material in fuzes and detonators for military purposes, but both France and Germany have used it to a limited extent in commercial detonators.

The azide was manufactured in Germany at the plant of the Rheinish Westfalische Sprengstoff Gesellschaft located at the little town of Troisdorf, near Cologne; in France it was manufactured at Hery by Davey, Bichford, Smith & Cie., who own the patents obtained by Hyronimus. The general method employed in the preparation of lead azide and the one used at both the above plants consists in treating a dilute aqueous solution of lead acetate with

Lead Azide Precipitated from Water. x 100.



Lead Azide Precipitated from Alcohol. x 100.

a dilute aqueous solution of sodium azide. The reaction is carried out in a revolving drum or barrel located behind a barricade. The barrel is made of nickel and is corrugated inside to facilitate the mixing of the charge. The desired amount of lead acetate is first run into the barrel, and the drum then rotated at about 15 to 20 r. p. m. The solution of sodium azide is allowed to run very slowly into the agitated lead acetate, the flow being controlled by an operator stationed outside of the barricade. The reaction takes place without delay and the operation is completed as soon as all the sodium azide has been added. The lead azide separates from the solution in the form of extremely fine crystals. The barrel is inverted and the contents run out into a trough where the crystals are washed repeatedly with cold water until neutral. The charge is then filtered and the crystals dried, after which the azide is ready for use.

Investigation of the explosive properties of lead azide, at Picatinny Arsenal and elsewhere, has shown that it is far superior to mercury fulminate in many respects. It is more efficient than fulminate in effecting detonation of high explosives, it is less sensitive to shock—if finely divided—and it will function normally even though it contains a high percentage of moisture, i. e., 5 to 10%; while mercury fulminate if highly compressed becomes insensitive to the spit of a black powder fuse, lead azide is not only capable of detonation but in fact is even more efficient when loaded under the most extreme pressures. Lead azide does not decompose spontaneously at temperatures below 326° C, whereas mercury fulminate explodes at 186° C. And further, the azide does not react with metals as readily as does mercury fulminate.

After considering all the above points in favor of lead azide, the question immediately arises as to why mercury fulminate has not been entirely supplanted by the azide. The answer to this question is given by one peculiar property of the azide, which has rendered its manufacture extremely hazardous. This property is an unusual variation in sensitivity with size of crystal. If the solution from

which the azide precipitates is not agitated sufficiently, needle-like crystals of extreme sensitivity are formed. These crystals can be detonated by the lightest touch, as with a feather, and if they are of sufficient size will detonate spontaneously even though they are under water. This property of the crystals has been responsible for many serious accidents and given rise to lead azide's well founded reputation for treacherous action. The azide can only be used safely in the micro-crystalline state, and it is not unlikely that the extent to which it is used in the future will depend upon the development of a manufacturing process which will not merely *tend* to eliminate the formation of large crystals but actually preclude the possibility of such formation. The material if entirely free from comparatively large crystals would be less hazardous than mercury fulminate.

DR. G. C. HALE,
Chief Chemist, Picatinny Arsenal.

SMALL ARMS

American Army Rifle Popular in Sweden

CAPT. Thure Holmberg, a member of the Executive Committee of the Swedish Association of Riflemen, has recently, according to the Swedish press, proposed to the Swedish Army Administration that the American Army rifle and ammunition be tried in Sweden. "The American rifle," he says, "has a reputation for extraordinary precision, probably greater than that of any other military rifle. The superiority of American riflemen lately established at international shooting matches seems to be largely due, not only to ability to shoot on the part of the men, but also to their being equipped with superior weapons and ammunition. This seems to be proved by the better results obtained by riflemen of other nationalities when given an opportunity to use American rifles instead of their own. The American rifle has a caliber of 7.62 millimeters, which is considered by many to be especially favorable to precision. This is, however, open to discussion, as there is reason to believe that 7 millimeters is a more ideal caliber. However, it would be well worth while to make a close study of the American rifle and to compare it in its modified form as used by the American contestants with the present Swedish army rifle as well as the Swedish fm/23 model under trial."

CURRENT NEWS

Ordnance Organization of Sweden

CAPT. Theodor Jakobsson, Royal Ordnance Department, Sweden, a recent visitor to the Ordnance Office, furnished interesting information with reference to the organization of the Royal Ordnance Department of Sweden, with particular reference to plans for industrial mobilization. The Swedish Government maintains a commission for the preparation, study and revision of plans for industrial mobilization in the event of a national emergency. This commission furnishes the contact between private manufacturers of ordnance and the government officials responsible for the procurement of ordnance.

Leland Stanford University Reconnoiters

THE Leland Stanford University of Palo Alto, California, has sent Dr. W. J. Crook, of the Department of Engineering, to make an extensive reconnaissance of Ordnance activities in order to have available complete data for the establishment of the Reserve Officers' Training Corps Unit at that University. Dr. Crook spent several days in the Ordnance Office in Washington conferring with officers of the Department, and the procurement organization of the Office of the Assistant Secretary of War. His itinerary includes Aberdeen Proving Ground, Watertown Arsenal, Picatinny Arsenal, Raritan Arsenal, Rock Island Arsenal, and the Pittsburgh District Ordnance Office.

Ordnance at Sesquicentennial International Exposition

A REPRESENTATIVE of the Headquarters of the Sesquicentennial International Exposition, 5th and Chestnut Streets, Philadelphia, Pa., has visited the Ordnance Office for the purpose of obtaining preliminary data with reference to the Ordnance exhibit at the Exposition. The Exposition desires to have an exhibit showing past, present and future activities of the Ordnance Department.

"Duds" for Coast Artillery

IN THE interest of extreme economy and safety, the Ordnance Department is purchasing 12" cast iron target projectiles for the service practice of the Coast Artillery. The question of the use or non-use of service ammunition for target practice has many interesting sides. There is no doubt that firing a cast iron projectile is safer than firing a service projectile. The cost of a round is less, but on the other hand, the manufacturing experience involved in providing a cast iron projectile does not compare favorably with that involved in the procurement of a service round, and the contribution to the records of service rounds fired in the case of a cast iron projectile does not compare favorably in value with the record of firing of a complete service round.

Camp McClellan Ordnance Demonstration

THE Visitors' Day program for Camp McClellan, Alabama, July 18, 1925, included an Ordnance demonstration. Machine guns, trench mortars, one-pounders, 75 mm. field guns, grenades, chemical ammunition and tanks made up the list of items demonstrated. The demonstration of Ordnance preceded a tactical demonstration of the Infantry battalion in attack on a fortified position.

Training Appropriations to Pay for Ammunition

A CHANGE in Ordnance Field Service Bulletin No. 3 will soon announce additional items of ammunition for which the appropriations for training the National Guard, R. O. T. C., C. M. T. C. and Organized Reserves will be charged. A few of the important items for which the training appropriations must pay are: Target practice projectiles for 14" and 16" guns; propelling charges for 6" guns, demolition and practice bombs of all weights and types, caliber .30 armor-piercing and tracer ammunition, caliber .50 ammunition of all types, and new types of pyrotechnics.

The question of reimbursement for ammunition consumed in training of components of the Army of the

United States other than the Regular Army is of vital importance to the entire War Department and interest in this question will increase as surplus stocks of ammunition diminish.

Post-War Development of Propellant Powders

A STUDY of a report contained in a recent issue of the Digest of Activities of the Ordnance Department, on the history and present status of post-war development of propellant powders, shows that the major activity has been the development of powder for the 75 mm. field gun. The objective has been a reduction of flash without increase of smoke, and a powder less hygroscopic than the World War powders. A complete service test of the various experimental powders will require years, but the progress to date is considered satisfactory.

"Tattoo"

FROM the publicity literature released in connection with the Aldershot Searchlight and Torchlight Tattoo, a military spectacle staged during Ascot Week, June 16-20, there comes an interesting definition of the word "tattoo." It appears that the word "tattoo" was brought to England during the seventeenth century by Marlborough's troops from the Netherlands, where, as "Tap-to," it ordained the stoppage of liquor supplies at a fixed hour each evening. Subsequently it attained dignity and became an imposing ceremony, and for a number of years has been the name given to an elaborate military exhibition appealing to popular interest as a means of supporting charities within the Aldershot Command.

16-Inch Howitzers at Fort Story Tested

PROOF firing of the four 16-inch howitzers, Model 1920, recently emplaced at Fort Story, Va., was conducted on May 14 and 16, 1925. These weapons are a part of the coast defenses of Chesapeake Bay and comprise a unit in the defense of that body of water and its tributaries which lead to the National Capital and several important industrial centers. The howitzers are 25 caliber with a maximum range of 15 miles, using 2100-lb. projectiles, having a velocity of 1950 f.s. The characteristics of the howitzer carriages are somewhat similar to the carriages for the 16-inch guns, Model 1919 M II, emplaced at Fort Tilden, N. Y., and described in the November-December, 1924, issue of ARMY ORDNANCE, page 587.

Proof firings were conducted under the direction of Lt. Col. John H. Read, Jr., Ordnance Officer, 3rd Corps Area; assisted by Capt. G. W. Owens, Ordnance Officer, Coast Defense, Chesapeake Bay; Mr. H. B. Hambleton, of the Artillery Division, Office of the Chief of Ordnance; Mr. M. V. McLaughlin, armament foreman, and Mr. H. M. Hunter, ammunition foreman of the 3rd Corps Area. Mr. Frank Poughkeepsie, of the Technical Staff, Aberdeen Proving Ground, took pressures in the recoil and counter-recoil cylinders, while Mr. C. H. Jeffers, resident machinist at Fort Monroe, took the powder pressures. Four rounds were fired from each howitzer at various pressures and elevations. Test data were recorded as follows:

Howitzer

No. of Rd.	Wt. of Charge	Wt. of Projectile	Percent of Service Charge	Mean Pressure Lbs. per sq. in.	Maximum Pressure	Elevation of Howitzer	Recoil in Inches
1	263.	2100	75	27,375	29,500	5°	31.5
2	309.	2100	100	36,500	38,200	45	37.375
3	324.5	2100	110	40,150	44,300	5	34.25
4	333.75	2100	115	41,975	45,200	65	37.

Carriage

No. of Rd.	Elevation	Counter-Recoil Cylinder Upper Right	Counter-Recoil Cylinder Upper Left	Counter-Recoil Cylinder Lower Right	Counter-Recoil Cylinder Lower Left	Recoil Cylinders Upper Right	Recoil Cylinders Upper Left	Recoil Cylinders Lower Right	Recoil Cylinders Lower Left
1	5°	5227	4429	....	5309	....	....	1422	1908
2	45	....	....	1665	1846	3431	3666	2015	2694
3	5	5409	4338	4238	5691	....	....	2074	2370
4	65	....	....	1241	1271	4559	3910	2331	2619

The maximum powder pressures recorded were somewhat higher than was expected, due, it is believed, to the wide variation in pressure cylinders used. The mean powder pressures given above are the average of two pressure gauges. All four howitzers and carriages functioned satisfactorily in all respects.

The following visitors were present and witnessed the firings: Col. Edward Carpenter, C. O., Coast Defenses of Chesapeake Bay; Col. R. S. Abernathy, C. A. C., President, Coast Artillery Board; Lt. Col. A. H. Sunderland, C. A. C., C. O., 12th Coast Artillery; Maj. K. T. Blood, C. A. C., Member, Coast Artillery Board; Maj. C. A. Waldman, O. D., Office of the Chief of Ordnance; Capt. C. C. Terry, O. D., Office of the Chief of Ordnance; Lt. Philip Schwartz, O. D., Secretary, Coast Artillery Board; Lt. John R. Burnett, C. A. C., O. O., Ft. Story, Va.; Mr. W. E. Yocum, Office of the Chief of Ordnance.

Muscle Shoals Steam Power Plant in Full Operation for First Time

FOR the first time since 1921, when its lease to the Alabama Power Company began, the steam power plant of United States Nitrate Plant Number 2 is operating at full capacity. Heretofore it has operated at varying capacities but not until now, to relieve the shortage of hydro-electric power caused by the severe drought of the early summer, has it been called upon for its full output of 60,000 kilowatts. This power is being turned into the interconnected super-power system of the Alabama Power Company to feed the States of North Carolina, South Carolina, Alabama and Georgia.

Nitrate Plant Number 2, one of the largest ordnance plants in the world, built to help make the United States independent of outside sources of nitrates for explosives manufacture, is occupying the exceptional status of earning a cash return to the Government. Under the terms of the lease, the United States receives a revenue of approximately $2,500 per day during the period of capacity operation of the plant.

The plant, which was built by the J. G. White Company, contains a Westinghouse 60,000 kilowatt turbine-generator, one of the largest power units in the world. All of the other equipment is of such type as to make the plant a model of efficient operation. The exciter for the generator, a Westinghouse 300 kilowatt turbine-generator, itself is of capacity great enough to light a small city.

This plant is not to be confused with the Wilson Dam Hydro-Electric Power Plant at Muscle Shoals.

Book Reviews

The Naval Side of British History. By Geoffrey Callender, F. S. A. Boston: Little, Brown and Company. 1925. 305 pages. $3.50.

THIS volume is an excellent exposition of that somewhat technical subject of sea power as illustrated by the history of England and told by an author already familiar to British readers as a writer on naval subjects. Its scope is broad, starting (as is customary) with Alfred the Great, although the first sustained assertion of naval consciousness is shown to have occurred in the time of Henry VII and his immediate successors. Even this was also an isolated instance and it remained for the Commonwealth to readopt measures bringing as a result evidences of sea power, which thereafter may be said to be practically continuous, although subject to periods of blight as well as growth.

By far the most interesting feature of the book is the preliminary statement that, geologically, the Rhine delta and the Thames are part of the same system and even now, when seas intervene, their interests, as represented by Antwerp and London, are closely bound together. Then follows the development of the idea that England has, from time immemorial, unleashed all the fury of her power whenever Antwerp was hostile or was in danger of falling into hostile hands. Parma was to cross the channel to England from Antwerp, after the Spanish Armada had cleared the way for him, but Drake and his brothers in arms accomplished their miracle in 1588. When Louis XIV tried to pounce on Antwerp, England joined her late enemies, the Dutch, and together with Sweden foiled the French in 1668. Again and again during the numerous conflicts of the 18th and 19th centuries, England was on the side guarding Antwerp, lest it fall into the hands of an overwhelmingly strong continental power. So when Antwerp fell in 1914, it is shown to be almost inevitable that three centuries of consistent policy should be crowned by a final alignment of British might.

It was not always that English admirals received the honors that their King and country could bestow upon them, for the list of executions, dismissals and censure for real or apparent faults is an unexpectedly long one. That many of their defeats were directly attributable to royal or ministerial shortcomings of a recent past, had no effect on popular verdicts. By the time the warfare incident to the loss of the American colonies was ended, matters on this score improved, for the chronicler states: "If the epoch has one redeeming feature, it is this: that * * * * * no admirals were publicly abased or privately butchered by way of expiation for failure of the people to know the things which belong to their peace."

The author becomes the apologist for Pepys (he of the diary), stating that the diary was discarded nearly five years before he went to the Admiralty and that his frivolity was common to all youths of the Restoration era. There are some five thousand letters of his, which prove his industry, and there are several testimonials as to his efficiency. As we recollect the complete diary, his shortcomings would hardly receive front page recognition from our modern dailies. As to when he discarded it, it was his failing eyesight which finally forced him to forego writing more. Moreover, the steady record of presents received and the evident rapid increase in material prosperity, leave no doubt as to the power he wielded not only for the navy's good, but for his own. The author bewails the graft in the administration of the navy in later days, but finds nothing but praise for the efforts of Pepys.

The adoption of the first naval signal book by Admiral Kempenfelt in 1782; the origin of the classification of ships in "tunnage" capacity; and the adoption of various devices for use in navigation, are some of the interesting scraps of information to be found in both the reading matter and the chronology appended. He gives credit for the design of the "Dreadnaught" class of battleship to the Italians, working from 1906-8 (the year of her launch), overlooking our projected Michigan Class, which was the forerunner of the idea and embodied those principles which survive today. His handling of the American Revolution, the War of 1812, the work of Mahan and our participation in the World War, is considerate and with evident sympathy for us.

His style is somewhat rhetorical in spots, calculated to make the British bosom swell with pride and appreciation, with little or no sacrifice of accuracy. The volume is a valuable addition to that already large number of books which patiently instills into the average Briton an appreciation of his present position as taught by history. Would there were more similar books presenting the naval side of our history in as readable a form. Like as not, though, our various peace societies would hail it with an epithet of ten letters, beginning with "p" and ending in "anda."

Robert Maclehose and Company, of Glasgow, have done the printing for the American publishers with but few typographical errors. A careful index and an extensive chronological table, together with a facsimile of Behaim's Nuremberg map of the globe of 1492, complete the offerings of a volume of more than usual merit.

American Society for Testing Materials — Proceedings 1924. Philadelphia: American Society for Testing Materials. 1925.

THE proceedings are published in two volumes of 1173 and 1133 pages. The first volume contains the reports of 35 standing committees and discussions, 87 tentative standards, the annual address of the President and

the annual report of the Executive Committee. The second volume contains 47 technical papers and discussions.

With the exception of the reports on the effect of sulphur and phosphorous in steel, there is little in Volume I that would appeal to one interested in purely general information concerning material, but for the practical man who has to furnish or buy material on specification it should be of great interest. The preliminary reports of the joint committee on the investigation of sulphur and phosphorous in steel is worthy of very careful study and from a theoretical point of view could be classed with the technical papers.

Volume II is divided into 8 sections:

A. A symposium of four papers, their discussions and a bibliography on the effect of temperature upon the properties of metals. These papers are mostly a review of the work of various investigators and contain little that is new. The symposium, however, presents for easy reference much valuable data. The bibliography is quite complete and affords the references to enable one to obtain the detailed information so necessary for further research along these lines.

B. A symposium of 13 papers and discussions on Corrosion-Resistant, Heat-Resistant, and Electrical-Resistance Alloys. Many of these papers are reviews of the work of various investigators, others are more or less detailed reports of original work. These papers contain much valuable data and should prove of great value to those interested in alloys having these properties.

C. A section on fatigue of metals contains four papers and discussions. These papers present a review of previous work and new material. Much valuable data on this little known property of alloys is presented.

D. A section of general metals contains 8 papers and discussions dealing mostly with ferrous alloys. These papers present data on various tests, etc., of low carbon steels, manganese steel, cast iron and various methods for determining the corrodibility of metals.

E. A section of concrete, gypsum and brick contains 7 papers and discussions. These papers deal principally with the effect of various impurities on concrete, etc. The masons and designers using this material are directed to these papers, where they should find considerable helpful information.

F. The section on paints and oils contains 4 papers and discussions. These papers deal with the various tests on varnishes and oils and should be of interest to paint makers and users, to oil refineries, and designers of transformers.

G. A section on timber contains 1 paper and discussion on the defects and their influences which occur in various structural timber.

H. The section on testing and testing apparatus contains 7 papers and discussions. These papers deal with testing thin metal, determination of Poisson's Ratio and sampling; they should be of particular interest to the inspector and designer.

John Viscount Morley. By Brig. Gen. John H. Morgan. London: John Murray. 1924. 10/6.

BRIG. Gen. John H. Morgan was for many years an intimate friend and advisor of the late Lord Morley. What he has written naturally contains conversations and discussions that give one an insight into the life and work of the late British statesman which could not possibly be available through a more formal account or even in a more intimate biography. General Morgan emphasizes from the start that his attempt is not to extoll the life work of Morley but rather to describe him in his more intimate characteristics as he was known by a friend.

A perusal of this volume has much food for thought for the casual American reader. There are so many British points of view explained in it which in themselves are quite different from the American viewpoint as to warrant study and possible emulation. For instance, in the conversation between Lord Morley and General Morgan as recorded on page 94 et seq., this thought is expressed,

J. H. M.: "Yes, when I worked with General Weygand, Weygand told me that Foch once concluded a course at the *Ecole de Guerre* with the words to his students, 'Gentlemen, learn to think.'"

Lord Morley: "But surely that's the last thing a soldier should do. I can't imagine a commanding officer saying that to his troops."

Here is a theory essentially British, partly American, but at best little brought into play in this country, at least with respect to military discipline as we understand it. There have been notable cases in point in American history some of which occurred in the immediate past.

Again we find the enunciation of a doctrine such as this, "If any servant of the Government threatens that if his advice is not followed he will resign, tell him that his resignation will be accepted." This theory has embodied in it the essential factors of what may be said to make British statesmen the world characters many of them have been and are. In it we find the essence of their method of government, and so throughout the book there are purple patches which alone can be made food for much meditation.

The author explains that three of the four chapters which deal exclusively with Lord Morley's works appeared in periodicals before they were gathered in this collection. The three chapters of remarks were partly published some months after Lord Morley's death and, in the words of the author, "would probably never have been written at all had I not been impressed by the one-sided and partial character of the many 'appreciations' written by others after that mournful event."

While General Morgan expressly states that he had no intention of writing a biography, and in the main his book is not exactly that, he nevertheless has gathered together accounts of many instances which are far greater in giving valuation of the man than any biography could ever be. It is interesting thus to compare a conversation which he records with Lord Balfour, on page 102, wherein Balfour is quoted, "All good biographies are compounded of good letters and good conversations, Trevelyan's 'Macaulay' and Boswell's 'Johnson' for example * * * As for Morley, he was never a good speaker, but he is a brilliant conversationalist. His fault in politics is that he's too negative." If this statement of Balfour is correct then General Morgan has written a good biography in spite of himself.

The Battle of Gettysburg. By George Gordon Meade. Ambler, Pa.: George Gordon Meade.

THIS narrative of the Battle of Gettysburg was compiled from the original account written by General Meade's son, Colonel Meade, who served on his father's staff as an aide during the battle.

To properly understand the Battle of Gettysburg, one should have a thorough knowledge of the entire history of the Civil War, an impossibility for the average person, including officers of the Army. This account, which is very much boiled down, is concerned only with the battle itself, and is primarily intended to show the parts taken by the commanders of the opposing armies. The book is well illustrated with maps and gives a very clear picture of the Battle of Gettysburg. A great deal of local color is included in the narration of events by reason of the fact that the original author was so familiar with the struggle.

The narrative, of course, is naturally somewhat colored by the fact that the author was so intimately acquainted with the Army of the Potomac, not only as an officer of that Army, but as a son of General Meade, its Commander-in-Chief. It is probably as true a picture of the Battle of Gettysburg as it is possible for one person to compile.

The New International Year Book. A Compendium of the World's Progress for the Year 1924. Editors: Frank Moore Colby and Herbert Tredwell Wade. New York: Dodd, Mead and Company. 1925. $6.75.

THE International Year Book has become a regular feature of annual publications of this country giving an accurate resumé of American progress in all branches of the arts and sciences year by year. Since its inception in 1898 it has been a product of Frank Moore Colby whose literary ability and sense of values have made it an increasingly valuable reference document. We regret that the untimely death of Mr. Colby has placed the burden on other shoulders, but the task is carried out with his same painstaking endeavor so that the Year Book for 1924 is even a better and more comprehensive volume than its predecessors. It is now in the able hands of Herbert Tredwell Wade who is to be congratulated not only for the general character of the work but for the completeness with which every detail has been handled.

To describe accurately the contents of such a volume as this is not only impossible in the space of a short review but is probably unnecessary to the majority of our readers. Suffice it to say that all branches of science, current events and the arts are fully treated. It can be seen at a glance that the year 1924 was productive of great accomplishments in many lines of endeavor and that American progress was probably advanced more in that year than in any of those immediately preceding.

For members of the Army Ordnance Association the review of "Military Progress," by Col. John J. Bradley, Inf., U. S. A., will be of particular interest. Colonel Bradley has contributed to the volume an authentic account of American military advancement during 1924, and his knowledge of developments in matériel is amply demonstrated in the complete accounts he has given the various ordnance activities of the year.

The book is interspersed with some well-wrought maps, and the illustrations are most commendable. Throughout it is a volume of excellent quality and is recommended as a reference book for those who would have at hand in systematic arrangement the accomplishments of 1924.

The A B C of Atoms. By Bertrand Russell. New York: E. P. Dutton & Co. 1924.

SCIENTIFIC investigators usually present the results of their research in language that is unintelligible to the layman. There is need, therefore, for writers like Russell, who is one of the best known popular writers on scientific subjects, to translate the reports of scientists into everyday language.

In this book, the author has attempted to explain, in non-technical language, what is known about the structure of atoms and how it has been discovered, in so far as this is possible without introducing any mathematical or other difficulties. "What has been discovered about atoms by modern physicists is doubly amazing. In the first place, it is contrary to what every man of science expected. In the second place, it seems to the layman hardly credible that such very small things shoud be not only observable but measurable with a high degree of accuracy. It is remarkable that, like Einstein's theory of gravitation, a great deal of the work on the structure of the atom was done during the war. It is probable that it will ultimately be used for making more deadly explosives and projectiles than any yet invented." The scope of the book may be seen from the chapter headings, which are in part as follows: The Periodic law; electrons and nuclei; the hydrogen spectrum; the theory of quanta; rings of electrons; X-rays; radio-activity; the structure of nuclei.

This book may be recommended to the man of science as well as to the layman who wishes to obtain a general knowledge of modern theories of the constitution of matter.

Absorption of Nitrous Gases. By H. W. Webb. New York: Longmans, Green & Co. 1923. $8.50.

IN THE more important processes for the fixation of nitrogen an intermediate step is the production of oxides of nitrogen. These gases must be absorbed in water or other medium in order to provide for their technical utilization. In many plants, particularly those in which nitrous gases are produced only as a by-product, a lack of knowledge of the chemistry of the absorption process results in serious losses. The author has endeavored to point out the way for the most efficient operation of such recovery plants by making clear the chemical theory involved and illustrating its application to the practical operation of the plant.

A chapter on Theoretical Problems of Absorption discusses the effects of variations in temperature, pressure, concentration, circulation, etc., of the gas mixture in actual tests in operating absorption systems. Other chapters discuss the types of construction of absorption towers, and other parts of the plant equipment, the various tower filling materials, gas circulating and measuring equipment, pumps and other apparatus necessary for the

handling of acid in the absorption system and its storage after production, acid-resisting cements, etc. Two chapters are devoted to the production of concentrated nitric acid and synthetic nitrates and nitrites.

Of special value to the chemist is the excellent discussion of the properties of the oxides and oxyacids of nitrogen, to which 90 pages are devoted, and the chapter on Analytical Control, covering a detailed account of the various methods used for sampling and analysis of both gases and acid. The value of the book from the industrial standpoint is increased by the frequent discussions of cost factors in comparing different processes and systems.

The extent to which the author has covered the literature is shown by the many references cited, actual count showing 200 such footnote references in the 90 pages of Chapter I alone. The book is written in entertaining style, and merits a place in any technical or scientific library.

The Constitution of the United States: Yesterday, Today and Tomorrow? By James M. Beck. New York: George H. Doran Company. 1922. $2.50.

HON. JAMES M. BECK, LL.D., an honorary member of Gray's Inn, officer of the Legion of Honor, and until recently Solicitor-General of the United States, takes as his thesis for this work, "The American Constitution is the most conspicuous and effective manifestation of a higher law. That such a subjection of the living to the higher law as evolved by the dead should, in this feverish age, create antagonism is natural, and the purpose of this book is to explain the historical evolution of that constitution, its formulation in 1898, and its fundamental political philosophy." The work which Mr. Beck presents in proving this premise is without doubt one of the most comprehensive and enlightening treatises on our Constitution that has yet been presented.

In the first portion of the book we have a narration of the events which lead up to adoption of our Constitution presented in a most fascinating way. This portion of the book reads in true romantic style and it is doubtful if any other commentator on our much discussed charter has ever told or commented upon the happenings in such an entertaining way.

It is in this portion of the book that the author draws his conclusions and philosophizes on the meaning of our Constitution and the future it holds for us that Mr. Beck's broad insight as one of America's foremost constitutional lawyers is shown. A careful reading of his text is ample proof that his much heralded fame as our foremost expounder of the Constitution is well deserved, while at the same time his comments will convince—if there are any who must be convinced—of the great worth of the Constitution.

The book is replete with little snatches of historical value, the recording of which adds immensely to its true worth. As an instance, one might cite in this connection the feelings of loyalty and friendship which existed between General Washington and Dr. Franklin in correspondence exchanged between them when Franklin was at the point of death. "To Washington, Franklin wrote:

'I am now finishing my eighty-fourth year, and probably with it my career in this life; but in whatever state of existence I am placed in hereafter, if I retain any memory of what has passed here, I shall with it retain the esteem, respect, and affection, with which I have long been, my dear friend, yours most sincerely.' "In replying to this touching farewell of an old friend, Washington wrote: 'If, to be venerated for benevolence, if to be admired for talents, if to be esteemed for patriotism, if to be beloved for philanthropy, can gratify the human mind, you must have the pleasing consolation to know that you have not lived in vain. And I flatter myself that it will not be ranked among the least grateful occurrences of your life to be assured that, so long as I retain my memory, you will be recollected with respect, veneration, and affection by your sincere friend.' "

After reading Mr. Beck's book one is more than ever convinced of the wisdom of General Washington's admonition,

"Observe good faith and justice towards all nations; cultivate peace and harmony with all. . . . It will be worthy of a free, enlightened, and, at no distant period, a great, nation to give to mankind the magnanimous and too novel example of a people always guided by an exalted justice and benevolence; of the foresight of Justice Marshall's statement, "The Government of the United States has been emphatically termed a government of laws, and not of men"; and of the truth of the proverb, "Where there is no vision the people perish."

The Abolition of War. By Sherwood Eddy and Kirby Page. New York: George H. Doran Company. $1.50.

FROM time to time books appear dealing with war, its causes, consequences and cure, and, as a rule, their statement of the case to the military mind is lamentably weak. Mr. Sherwood Eddy has prepared one of the strongest cases against war which the writer has ever read.

It is of interest to note that Mr. Eddy saw fighting in the British, French and American lines during the great war. As a consequence of his own personal experience, he presents many powerful arguments based on his own observation.

It is also of interest to note that the author, during the World War, wrote the book called "The Right to Fight," in which he defended the entry of the United States into the World War and condemned the position taken by pacifists. This is not the first case of a writer who has had a complete change of attitude during the course of the World War.

Mr. Eddy bases his case on three basic arguments: First, war is wrong in its methods; second, war is wrong in its results; third, war is unchristian.

The second part of the book contains questions and answers concerning war. These are divided into chapters as follows: The use of force, police and war; the results of war; the causes of war; substitutes for war; the churches and war; the citizen and war.

The entire book is very convincing and it is impossible to read this indictment of war without feeling that war is everything the author says. However, the solution of the authors will not entirely meet with the approval of the thinking man. The author reaches the decision that since Christ, if a citizen at the present time, would not go to war; therefore, no other citizen who considers him-

self a Christian should go to war. He admits that this is a very difficult thing to do, but he believes that in the end it is for the best interests of all.

In the questions and answers, the following is a typical question: "Is it not true that more good than harm resulted from our Revolutionary and Civil Wars?" The author answers this by stating that Canada, Australia and New Zealand secured their liberty without war, and that the rest of the civilized world emancipated slaves without war.

However, the author does not satisfactorily prove his case that the Revolutionary War did not accomplish more good than harm. To the ordinary mind, the present political independence of the United States and other great nationalities is due to great upheavals and revolutionary movements on the part of the common people, which were accomplished by means of force, such as the granting of the Magna Charta, the American Revolution and the French Revolution. If it had not been for the American Revolution, it is doubtful if the world would be as far advanced as it is in the enjoyment of life, liberty and the pursuit of happiness.

The authors in their case against war do not believe the maintenance of political liberty worth the cost which involves the denial of the spirit of the teaching of Christianity as exemplified in the New Testament. The authors admit that portions of the Old Testament justify war. Their contention is that the teachings of the Old Testament are not as valid for Christians to-day as the higher revelation of the New Testament.

Every thinking man should read this book. It presents the various phases of the question in simple and brief statements. It should be read if for no other reason than the fact that it will cause the reader to carefully consider the war question, and to weigh in the balance the sacrifices entailed by war as against the benefits which accrue.

War will end naturally and inevitably when individuals have progressed to the point that it is no longer necessary to make laws requiring obedience, and to maintain police for the purpose of enforcing compliance with such laws. Governments cannot put the Golden Rule into effect until individuals do so. It is as impracticable for governments to carry out the teachings of the New Testament as it is for individuals to do so. Wars will end when Mr. Sherwood Eddy, Mr. Kirby Page and the rest of us are willing to carry out Christ's injunction to the rich young man.

The Americana Annual, 1925. Edited by A. H. McDannald. New York: Americana Corporation.

THE 1925 edition of The Americana Annual is of particular interest to the members of the Army Ordnance Association because it contains under the title "Modern Ordnance" a reprint of General Williams' article under the same title which was published in this journal November-December, 1924, and which was held generally as one of the best current descriptions of post-war ordnance development that has yet appeared in print.

But there are other items in the 1925 Annual of The Americana which make it a very valuable reference book. It has brought up to date practically all of the major topics which our encyclopedias generally treat, and in addition is illustrated with excellent maps which add considerably to its value. Mr. A. H. McDannald is due a large measure of credit for publishing The Annual in its present form, and his interest and activity in all current developments both in ordnance and commercial industries warrant full treatment of these topics in his work.

In view of the thoroughness which characterizes the entire work we can only hope for this book the widest circulation and recommend its constant use for those who would have the latest information on current events.

Metallurgy of Aluminium and Aluminium Alloys. By Robert J. Anderson. New York: H. C. Baird & Co., Inc. 1925. $10.00.

THIS is the only American book on the subject published since the work of J. W. Richards, the last edition of which appeared in 1896 and is now entirely out of date. It will therefore fill the need for a modern treatise on aluminium and its alloys.

The book is much wider in scope than the title suggests. Among the subjects treated are bauxite deposits of the world, production of bauxite, bauxite mining, uses of aluminium, and markets and trade statistics.

"The book is designed to serve as a text-book of aluminium metallurgy, not only for engineering colleges, but also for metallurgical, automotive, mechanical, chemical, and electrical engineers, and others engaged in work allied to engineering or metallurgy."

The introductory chapter contains an account of the aluminium industries of the world by countries, a discussion of market, trade statistics and aluminium tariffs.

There are chapters on physical-chemical properties of aluminium and aluminium alloys; corrosion of aluminium and aluminium alloys; alloys of aluminium; uses and applications of aluminium and aluminium alloys; preparation of aluminium alloys; aluminium and aluminium-alloy melting practice; production of secondary aluminium and aluminium alloys; aluminium alloy foundry practice; casting losses; defects in castings and their prevention; production of die castings and permanent mold castings; micography and micography of aluminium and aluminium alloys; drawing and other fabricating operations, finishing, machining, and electroplating aluminium and aluminium alloys.

This book should be read by all engineers and executives who are interested in the use of aluminium and its alloys. To the specialist one of its greatest values will probably be found in the bibliographies at the end of each chapter.

Fighting the World. By Count Michael Karolyi. Translated by E. W. Dickes. London: Kegan Paul, Trench, Trubner and Co., Ltd. 1924. 34 chapters. 21s.

A FEW months ago, a distinguished foreigner applied for admittance to the United States for the purpose of visiting his sick wife in a New York hospital. He was permitted to visit this country but a pledge was exacted by our Government that he would refrain from public utterances while a visitor to our shores. There was considerable speculation on the part of the American public as to the reason for this unusual action by our Government and the greatest interest in the interviews given

to the press by the visitor when he crossed the border into Canada and was thus released from his pledge. The visitor was Count Michael Karolyi, the stormy petrel of Hungarian politics, erstwhile President of the infant Hungarian Republic and now an exile from his native land.

Count Karolyi has written his memoirs under the somewhat disquieting title of "Fighting the World." His writings are those of a man wounded and exhausted by continuous combat in the interest of an idea, the independence of Hungary. Much of the subject matter is devoted to the answering of charges levelled at Karolyi by his enemies. Liberalism and an opposition to the all-pervasive German influence in the Dual Monarchy caused most of Karolyi's political troubles. He opposed the World War and made every effort to cause the withdrawal of the Austro-Hungarian forces and a separate peace with the Allies on the basis of Wilson's Fourteen Points. Naturally he was called a defeatist and a traitor. George Washington was also regarded as a traitor by the British. In America, the viewpoint would be somewhat different and the word "patriot" would be used instead. One cannot resist the feeling after reading the memoirs of Karolyi that the "traitor" in Viennese eyes was a "patriot" to those of Budapest.

The work is well written and has been admirably translated into idiomatic English by Mr. Dickes. However, the book ends too abruptly. The author breaks off after detailing his struggle to rise to power as Premier of Hungary and fails to carry us forward into a still more interesting period covering his decline and fall from power. If this period had been covered, a better side-light on present conditions in Hungary would have been provided, and the American public would have been in a better position to judge the merits of the action of our Government in preventing public speeches by Karolyi.

No review of Karolyi's memoirs would be complete without a reference to the wife of the author. Her loyalty to the ideals of her husband and her intelligent support of his program on all occasions contributed in no small measure to the temporary success which rewarded his efforts. In fact, the memoirs are based to a great exent on the notes kept by Countess Karolyi, since her husband lost most of his papers when he went into exile.

America To-day and To-morrow. By Alderman Sir Charles Cheers Wakefield. London: Hodder and Stoughton. $3.00.

SIR Charles Cheers Wakefield was the leader of a group of English citizens who visited the United States on behalf of the Sulgrave Institution, whose principal object was a strengthening of the bonds of friendship between England and America and incidentally to present to the American people several testimonials of British esteem. This notable visit, which was so fully described in the American press, is perhaps fresh in the minds of many. The author publishes in this book an account of the various official receptions and visits of the delegation and also records his impressions of American men and institutions.

The purposes of the Sulgrave Institution probably have a more potent effect than any of the various other movements that have arisen from time to time with much the same aim. Sulgrave is the birthplace of the ancestors of George Washington, and about it has been gathered by the English people much tradition of real value. We feel that these portions of the book are as well known to current readers from other sources as from what the author has written of them.

The striking feature of the work, however, is a characteristic English description of American men and manners. Received as the delegation was by leaders in American public life, the author had excellent occasion to meet and converse with our statesmen and diplomats, and he has recorded most generous appreciation of all that was done for the delegation on a tour which embraced a greater portion of the United States. Being the official representative of an organized body whose one purpose is to foster American friendship, it seems that the pages of this work are permeated with a desire to be more American than English.

A former Lord Mayor of London is perhaps better equipped than any other English statesman of today to appraise our system of government and our commercial and industrial life. He has some very interesting things to say about Henry Ford and other American industrial leaders which, it is quite evident, are new thoughts for British consumption. All in all the book is a record of an outstanding occurrence in the early twentieth century. Sulgrave means more to the American people than any other English undertaking of its kind, and it is to be ardently hoped that the objectives of the Sulgrave Institution, so fully brought out in the pages of this book, will continue to produce a greater friendliness and better understanding between the two English-speaking nations.

Modern Military Map Reading and Sketching. By Captain Frank J. Pearson, Infantry, United States Army. Menasha, Wisconsin: George Banta Publishing Company. 1924.

THIS book is dedicated to the students of the Infantry School and embraces all phases of military map reading and sketching, starting from the most elementary principles and continuing through an explanation of the more difficult operations. As a basic treatise, it is very commendable. As a technical work, the Training Regulations on the subject are far more complete.

For all persons who have no knowledge of map reading or sketching whatsoever this book is a very excellent introduction to the subject. Its arrangement in chapters and paragraphs is particularly advantageous for classroom work. It is consequently an excellent text book preparatory to the more technical study of the subject.

If this book and the Training Regulations on the subject of map reading and sketching are read concurrently it will be found that they have been prepared along practically the same lines. It, therefore, lends itself as a key for interpretation of the more detailed and technical Training Regulations now published on this subject. The volume is well worth having in the professional library of all officers upon whom the duty of map reading or sketching may fall.

Atoms and Rays. By Sir Oliver Lodge. New York: George H. Doran Company. 1924. $3.00.

ANY work by such an eminent scientist as Sir Oliver Lodge is naturally read or studied eagerly by all those whose interests lie in the various physical subjects with which he deals.

The present book on atoms and rays purposes to cover developments in the theory of the structure of matter, especially such advances as have been made during the past decade. The researches of the past ten years which have revealed the constitution of the atom, the relation between movements of the electrons in their orbital paths and the characteristic lines in the spectra of the various elements under examination, the wide applicability of the quantum theory in considering all phases of the energetics of atoms, have been of such profound significance that it would seem that this period is likely to be regarded as one of the most fruitful in the history of science.

Sir Oliver Lodge covers the subject in the broadest way. His first chapter is headed "The General Structure of the Universe," and contains such sections as "The Ingredients of Matter," "The Building Stones of the Universe," "The Evolution of Mind." Upon such foundations he builds up the theory of the electrical constitution of matter and develops the idea of a miniature "solar system" involving the electron and the proton which go to form the atom.

The persistent inclusion of the theory of the ether seems a little strange at this time to those who have been accustomed to reading the many popular or semipopular expositions of Mr. Einstein's Theory of Relativity.

The quantum theory is broadly considered and its relation to the phenomena of radiation which accompanies the movement of electrons from one energy level to another is shown. The theory of spectra, of course, comes in for its share of the discussion, but the mathematical relationships are so infrequent, and sufficiently simple when they are introduced, that a reader who does not happen to have advanced mathematical training will not find these portions of the book beyond his understanding.

Some of the pages bear a rather heavy impress of the hand of the pedagogue, especially where modern views are somewhat arbitrarily clouded by opinions which were in vogue perhaps fifteen or twenty years ago. This, however, does not prevent a student from deriving a great benefit from a careful reading of this very well prepared book.

The Immortal Salient. Compiled by Lieut. Gen. Sir William Pulteney and Beatrix Brice. London: John Murray. 1925. $1.25.

"HERE the Invader Was Brought to a Standstill" is the inscription on seven monuments marking the Ypres Salient. Again and again, the Salient broke the flower of the German Army in its gallant but futile attempts to reach the channel ports, and it was from the Salient, tenaciously held by the British Army throughout the war, that the final sally was made which initiated the German retreat in that section of the line and brought the war to a close.

The defense of the Salient cost the British nation nearly three hundred thousand men in killed and wounded. For heroism and sacrifice on the part of those who fought there is no parallel in the history of the war, and the Salient has become in British eyes a place of pilgrimage for the many whose loved ones sleep in the cemeteries dotting the ground over which they fought and died.

For these pilgrims this book has been written. It is a guide book to the battlefields and cemeteries of Ypres. Philip Gibbs has in his inimitable style provided a foreword expressing the spirit of the defenders of the Salient. Then follows an account of the battles around Ypres and a description of the roads and routes of the locality. There has been included in the volume also a vivid account of the naval attacks on Zeebrugge and Ostend and the Belgian participation in the conflict, since the areas involved would naturally also be visited by a pilgrim to Ypres. Two excellent maps carried in a pocket at the back of the book complete the volume. Photographs and colored illustrations help the reader to a realization of the conditions in the Salient during the war.

This little volume is more than a guide book. It is a reverent tribute to the heroic dead of the long and dreary conflict of Ypres, and is intended for those who would take with them to Ypres the spirit of the Defenders of the Salient.

Two Ordeals of Democracy. By John Buchan. Boston: Houghton Mifflin Company. 1925. $2.00.

THIS is a very scholarly address, delivered before the students of Milton (Massachusetts) Academy upon the occasion of the dedication of their War Memorial Foundation, by John Buchan, an eminent British historian of the World War and distinguished man of letters.

Many of us who have had occasion to read the pronouncements of English statesmen and literateurs during the past few years have, no doubt, been struck by the significance which they attach to the American history of the Civil War period and the high esteem in which they hold the national characteristics emphasized by that conflict. Mr. Lloyd George, while prime minister, on many occasions extolled the great Lincoln, and the author of this book devotes many of its pages to character studies of Lincoln and Lee.

Aside from what the author has said concerning the men who participated in our War of the Rebellion, he presents a very thorough study and contrast between the conduct of our Civil War as compared with the World War. In the one he sees many prototypes which materialized in the later conflict, and in addition he sets forth theories of tactics and organization which he claims were foreshadowed by the Civil War.

Such a study coming from the hand of a brilliant Englishman can be productive only of a more genuine friendship between the two nations. That an English historian should be called upon, at the foundation of an American war memorial, is in itself significant of this fact, while his thoughts and elegantly expressed ideas concerning our Civil War, to say nothing of the high place in which he holds Lincoln and Lee, are indications, we take it, of a thorough realization of what that struggle meant for America and its bond of friendship between the two countries.

Recent Patents

Brief Descriptions of Inventions of Interest to Ordnance Engineers

Compiled by W. N. Roach, Chief, Patent Section, Office of the Chief of Ordnance

A number of patents have been issued recently in the Ordnance art of which the following may prove of interest:

Ammunition

L. E. REMONDY has been granted patent No. 1,541,279, for a mechanism for firing percussion or time fuzes. The fuze shown in this patent is intended primarily for use in projectiles of comparatively slow speed in flight though not limited to such use. The fuze consists essentially of a firing pin and primer, either one of which may be stationary or both of which may be movable, having interposed between them an axially movable sleeve or tube through which the firing pin operates and also provided with a resilient element such as a coiled spring between the firing pin and this movable tube and between the primer and the movable tube. The inventor claims that by this arrangement a comparatively sensitive fuze is secured which is not liable to accidental ignition during handling, the safety feature being secured by properly proportioning the strength of the springs and the mass of the parts between which the springs are interposed.

Patent No. 1,541,380, has been granted to C. H. Pearson for a primer chamber for fuzes. The main object of this invention is to permit the primer and detonator to be assembled in the fuze when desired without disturbing the operative parts of a mechanical time fuze. This is accomplished by providing a separate base member for the fuze containing the primer chamber which member may be assembled in operative position with respect to the timing gear without in any way disturbing the timing gear.

C. H. Pearson and F. W. Bold have been granted patent No. 1,543,232, for a fuze. The subject of this invention is a mechanical time fuze; the main object is to render such fuze more safe in handling, which object is attained by normally holding the primer in a position out of operative relation with the firing pin.

Otto Oesterlen and Karl Wieser have been granted patent No. 1,543,513, for a slow-combustion fuze for projectiles. The object of this invention is to secure uniform and complete combustion of the time train in a slow combustion fuze. This object is accomplished by providing a fuze having an annular chamber open at its forward end to the atmosphere into which the products of combustion may discharge. The air in this chamber is supposed to be placed under pressure due to the flight of the shell, and the air in the port communicating with the time train passage is subjected to pressure due to the rotary movement of the air in the chamber under the rotation of the shell.

Samuel Wiley, of Picatinny Arsenal, has been granted patent No. 1,543,689, for a fuze. This is a delay fuze suitable for use with grenades and is so constructed as to be held in safety position through means of combustible material which must be consumed before the fuze will operate.

Patent No. 1,545,139 has been granted to N. Greenwell, for a fuze. This is a delay fuze so constructed that its time of explosion after penetration is controlled by the character of the target; that is, whether the target offers a great resistance or only a slight resistance.

Patent No. 1,545,866 has been granted to P. D. Van Essen, for an instantaneous impact fuze for high explosive shells. The fuze consists essentially of a striker normally seated on the forward end of a tubular primer carrier in which carrier a spring is housed which is interposed between the striker and the primer. The striker is normally secured to the fuze casing and held slightly within the open nose thereof by a shear pin, and the primer casing has a heavy spring interposed between its rear end and the rear end of the fuze. On set-back the striker and primer casing move rearwardly shearing the shear pin and compressing the heavy spring. When acceleration ceases expansion of this spring forces the primer casing and striker forwardly until the striker projects from the nose of the fuze so that upon impact the striker moves rearwardly to prime the primer.

K. R. Brown has been granted patent No. 1,546,717, for an explosive composition and process of preparing the same. This explosive mixture is formed by dissolving a carbo-hydrate, specifically cane sugar, in a mixture con-

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sisting of glycerin and di-glycerin and then nitrating the mixture.

Patent No. 1,546,367 has been granted to K. R. Brown, for a perchlorate explosive containing nitroguanidine. An example of an explosive mixture in accordance with this patent is ammonium perchlorate 35; manganese dioxide 6; nitroguanidine 25; sodium nitrate 28; ground coal 5; and calcium carbonate 1.

Herman Staudinger has been granted patent No. 1,547,076, for a method of producing explosives. This method consists in bringing light metals of the first and second group of periodic classification and an explosive suddenly into intimate contact with each other, thus instituting a local detonation which acts as a priming means for the explosive.

Artillery

THE following patents relate more particularly to artillery:

N. E. Methlin has been granted patent No. 1,543,262, for a quick firing gun. The patent covers essentially a gun provided with two barrels, the one run out to battery by recoil of the other with which means, specifically, a fan, is used to operate on recoil of the barrels to circulate a cooling medium about the barrels.

N. E. Methlin has also been granted patent No. 1,543,263, for a piece of artillery. The patent relates to a counter-balance to render elevation of the gun easier and this is accomplished, in the case of a gun with two barrels, one of which is run out by recoil of the other, by so mounting them that the barrel in recoil position will counter-balance the barrel in battery position.

R. Stutzer has been granted patent No. 1,546,687, for a direction finder. This patent covers an apparatus for directing an object irrespective of its position, and consists of a sighting device and means connected to it for measuring angles, in conjunction with which is a condensing optical system disposed at a suitable distance from said object and having a screen in connection therewith. The graduations of the screen are extended over a considerable portion of the field of view of the condensing system and the focal length of the condensing system is so related to the screen that the graduations of the latter correspond to those of the means for measuring angles. The condensing system and its screen are carried by a stationary bearer.

O. Eppenstien has been granted patent No. 1,546,723, for a telemeter. This patent covers a telemeter provided with a deflecting device adapted to alter the relative position of two images of the object to be measured consisting of a pair of wedges rotatable relative to each other.

A. V. Baranoff has been granted patent No. 1,546,880, for an apparatus for teaching gunnery.

Small Arms

THE following patents are of particular interest in the field of Small Arms:

J. W. Gibbs has been granted patent No. 1,540,772, for a foresight. This foresight consists of a tubular member having its bore flared toward the front and having a cup shaped member secured in the rear end of the bore which member has a peep hole formed in the bottom thereof.

H. O. Russell and C. L. Paulus, of McCook Field, have

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been granted patent No. 1,541,282, for a feed box for cartridge belts of machine guns. This invention covers a feed box adapted to straddle a gun and having means for connecting the box to the gun, releasable from the gun by movement of the box laterally with respect to the gun.

T. H. Eichoff has been granted patent No. 1,544,566, for a cartridge extracting and ejecting mechanism for fire arms. This patent covers a device intended for extracting and ejecting a cartridge with less force than the usual cartridge ejecting device and one which will operate with less wear on the parts. To this end the extractor is so constructed that it partially releases the cartridge case during early stages of the movement of the bolt and before action on the case by the ejector, the extractor being restored to normal position by final movement of the bolt.

W. E. Dute has been granted patent No. 1,545,045, for a fire arm. The main object of this invention is to rotate the bolt manually from the left side of the gun. This is accomplished by providing a pinion on the left side of the gun engaging teeth in the bolt, the pinion being rotated by means of a lever connected thereto.

H. A. Cook has been granted patent No. 1,546,475, for a flexible rawhide rifle cleaner. This rifle cleaner is made of rawhide constructed in such a way as to be comparatively flexible and the same may be either pushed or pulled through the rifle.

J. Hedin has been granted patent No. 1,546,895, for an arrangement for increasing the life of rifled shooting weapons. The object of this invention is obtained by tempering the rifled wall of the bore adjacent to the mouth of the bore and leaving the remaining portions of the wall of the bore untempered.

Patent No. 1,547,072 has been granted T. Silcott, for a combination gun cleaner and screw driver. The inventor has provided in this structure a gun cleaner which may be used in cleaning a gun as well as a screw driver which is useful in assembling or disassembling parts of the fire arm.

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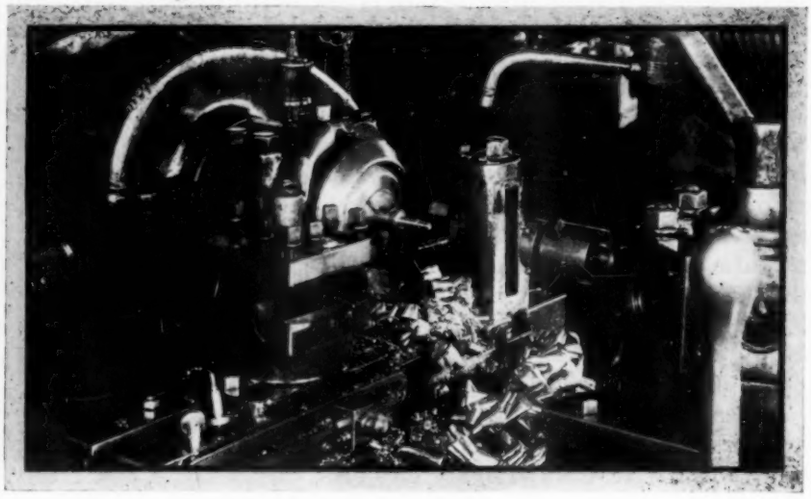

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